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ABSTRACT

Based on data provided by the National Assessment of Educational Progress, this study examines mathematics achievement in relation to various background variables, contrasts achievement levels of black and white (females and males) youth, and evaluates group achievement differences in the light of group differences in background variables. Students chosen for the study consisted of 4000 white and 600 black youths, aged 13 and 17. Background variables examined included region of residence, parental occupation level, reading materials in the home, level of parental education, and school grade in which the student is enrolled. Also considered among the 17 year olds were the effects of mathematics courses taken in high school and of grade point average. This report analyzes the systematic relationship found between mathematics achievement differences between blacks and whites and many of these variables, and discusses the findings' implications for predicting achievement. (GC)

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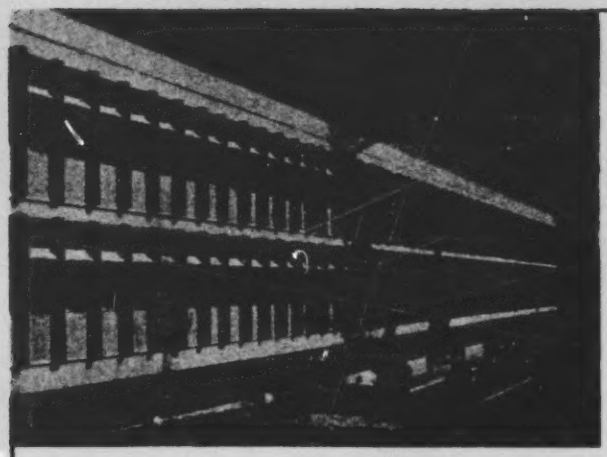

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MATHEMATICS ACHIEVEMENT LEVELS OF BLACK AND WHITE YOUTH

Lyle V. Jones, Nancy W. Burton, and Ernest C. Davenport, Jr.

Report Number 165

June, 1982

THE L. L. THURSTONE PSYCHOMETRIC LABORATORY
UNIVERSITY OF NORTH CAROLINA

CHAPEL HILL, N. C. 27514

Mathematics Achievement Levels of Black and White Youth

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L. L. Thurstone Psychometric Laboratory
The University of North Carolina at Chapel Hill
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ERRATA

Page	Line	
ii	7*	Replace "and low metro" with "metro and rural."
iii	-	Replace "age age" with "at age."
8	-	In Exhibit 1-5, on the ordinate, 4, 5, 6, and 7 should be .4, .5, .6, and .7.
20	-	In Exhibit 2-2, final column, the seventh entry should be 120 (rather than 20) and the final entry should be 256 (rather than 56).
21	-	In Exhibit 2-3, first column, 50.24 should be 50.2.
25	12	Replace "constuct" with "construct."
37	14	Replace "6" with "-6."
40	-	In Title, Exhibit 3-12, change "16" to "18" and change "Sample 1" to "Sample 2."
	-	In Exhibit 3-12, the entries for both races should be changed from "11.1 14.3 12.6" to "10.5 13.9 12.1"
41	22	Replace "shape" with "slope."
43	-	In Title, Exhibit 3-14, change "age 3" to "age 13."
57	-	In Exhibit 3-25, under "Age," change "16" to "17"; in the same row, the mean for black males should read "40," not "30."
68	9	Replace "22" with "20."
	10	Replace "14" with "10."
78	18	Replace "31 percent" with "25 percent."
82	-	In Exhibit 4-16, near center, "66/3" should be "66.3."
83	13	Replace "22" with "23."
	14	Replace "14" with "15."
	6*	Replace "17" with "16."
	4*	Replace "31" with "30."
	3*	Replace "35" with "34."
89	19	Replace "R_s^2" with "R_t^2."
91	-	In Exhibit 5-2, the entry ".01" for age 13, Sample 2, should read ".01*."
93	11*	Replace "then" with "than."
102	4*	Rearrange the numbers, "53.3 70.6 73.4 50.4" to read "50.4 53.3 70.6 73.4"

*Count lines from the bottom of the page.

Overview

In 1975-76, the National Assessment of Educational Progress undertook a special assessment of achievement in mathematics, collecting data from national samples at ages 13 and 17. Two samples were studied at each age. Each sample included more than 4000 white youth and about 600 black youth. Every individual in each sample was asked to provide answers to at least 40 mathematics exercises. In addition, information was collected from all individuals about their grade in school, the educational level of their parents, reading materials in the home, and, at age 17, their grade point average and mathematics courses taken in high school. From each of their schools, information was obtained about the type of community served by that school, the distribution of occupations of parents of students enrolled in that school, and the percentage of enrolled students who are black. The samples at age 17 included not only enrolled students, but also 17-year-olds not attending high school. All exercises were administered by professional administrators who used standard National Assessment procedures.

These data represent a rich source of information about levels of mathematics achievement of the nation's youth in 1975-76. They provide the opportunity to relate achievement to a number of background variables, to contrast achievement levels of black youth and white youth (and females and males), and to evaluate those group achievement differences in the light of group differences in the background variables. The present study was undertaken with these goals in mind.

In Chapter 1, we try to place the present study in context by commenting on changes in society that may have influenced educational achievement and, particularly, white-black achievement differences. We review some evidence that those differences have decreased in a variety of learning areas in the 1970s. While these changes were concomitant with or followed shortly after institutional efforts designed to accomplish equality of educational opportunity, we are not able to draw conclusions about causes of the declining white-black achievement differences. (Other evidence for decline in that difference comes from a comparison of our findings with those developed from the data of Coleman et al., 1966, collected a decade earlier. See Chapter 5.)

After describing in detail the National Assessment mathematics data and the variables selected for use in this study (Chapter 2), we proceed to investigate differences in mathematics achievement by race and sex, at ages 13 and 17 (Chapter 3). Mean achievement differences are found to be systematically related to a number of background variables, whether considered one at a time (Chapter 4) or simultaneously (Chapter 5).

The present study does not undertake an investigation of race differences in intelligence. An excellent statement of the issues and review of the literature on that topic is available (Loehlin, Lindzey, and Spuhler, 1975). Here we focus exclusively on achievement in mathematics, as determined from the National Assessment data, and on background variables that correlate with mathematics achievement.

The present study does not address itself to possible bias in the assessment procedure. The comprehensive work of Jensen (1980) provides useful suggestions for evaluating the question of bias, but we have not systematically applied those suggestions to the National Assessment data. We do believe that features of exercise administration designed to assure that each individual is encouraged to

perform optimally are features that would minimize any bias associated with race that might attend less carefully administered achievement tests. (We have performed factor analyses of mathematics performance, separately by race and sex. Results, not reported here, attest to the similarities of factor structure for both races and both sexes.)

Major Findings of the Study

1. Chapter 1 cites evidence that the educational achievement levels of black youth, in a variety of learning areas, have risen during the 1970s.

2. In 1975-76, the mean mathematics achievement score for black students at age 13 was about 1.1 within-group standard deviations below that of whites, and at age 17 was 1.4 standard deviations below that of whites (Chapter 3).

3. At age 13, sex differences in mean mathematics achievement in 1975-76 were negligible. By age 17, mean achievement scores for males exceeded those for females by about 1/4 of a standard deviation (Chapter 3).

4. At age 13, the variance of mathematics achievement scores for white males is larger than that for white females. By age 17, when out-of-school students are included, variances for white males and white females are more comparable. No consistently significant variance differences were found between black males and black females, nor between blacks and whites of either sex (Chapter 3).

5. The "growth" in mathematics achievement between ages 13 and 17 is greater for whites than for blacks, and is greater for males than for females (Chapter 3).

6. Mean achievement differences among race-sex groups remain essentially invariant under changes in scoring, from rights-only scores to scores corrected for guessing (Chapter 3).

7. At age 13, a number of background variables are related to mathematics achievement scores for both blacks and whites (Chapter 4).

   - For both blacks and whites, the largest differences--of 1 1/4 standard deviations--are found between those from families with a number of reading materials in the home and those with none.

   - For blacks, there is an equally large difference between those who attended school in high-income metropolitan areas and those from rural schools. For the white students, however, the performance difference between high and low metro schools is only 2/3 of a standard deviation. The mean achievement for black students in the high-metro schools is approximately equal to the national mean for all students.

   - Mean achievement differences of almost one standard deviation separate students of either race who were at or above grade for their age from those who were behind by one or more grades.

- For both races, children who reported the best-educated parents display average scores nearly one standard deviation higher than children who reported not knowing the level of education attained by their parents.

- A principal's report on the percent of professional and welfare parents in the school was used to create an occupational status variable that shows about 1/2 a standard deviation difference in average mathematics achievement between the extremes.

- 13-year-old students from the Southeast, on average, score about 1/3 a standard deviation below the rest of the nation.

8. At age 17, the effects associated with some of these background variables are different from those at age 13. (Chapter 4)

   - Grade, possibly because it can range from dropouts to early graduates, now is associated with 1 1/3 standard deviations difference in average achievement for blacks and 1 3/4 standard deviations difference for whites.

   - The number of reading items reported in the home is associated with 1 3/4 standard deviations difference in mean achievement for whites but only 1 standard deviation for blacks.

   - Mean scores for the high metropolitan and rural community types are 1 1/3 standard deviations apart for blacks; for whites the extremes are only 1/3 of a standard deviation apart.

   - Mean differences of 2/3 (for blacks) to 3/4 (for whites) of a standard deviation are associated with parental education.

   - Mean differences of 1/2 (for blacks) to 2/3 (for whites) of a standard deviation are associated with occupational status.

   - 17-year-olds from the Southeast score, on average, 1/5 a standard deviation below the rest of the nation.

9. Additional background variables, related to earlier achievement of students, are available at age 17 but not age age 13, mathematics courses taken in high school (MATHEXP) and self-reported high school grade-point average (GPA). About 2 1/3 within-group standard deviations separate achievement means for white students for low and high levels of GPA; about 1 3/4 standard deviation differences attend differences in MATHEXP for both blacks and whites; about 1 1/3 standard deviations separate achievement means for black students for low and high levels of GPA (Chapter 4).

10. At age 13, about 1/3 of the variance of individual differences is accounted for by regression on the background variables as a set. Of the variance accounted for, about half is related to school-to-school differences and about half is related to individual differences within school (Chapter 5).

11. At age 13, about 40 percent of the mean achievement difference between blacks and whites is accounted for by regression on the background variables. The bulk of that reduction in mean achievement difference is attributable to the school-to-school differences in the background variables (Chapter 5).

12. At age 17, some 30 percent of the individual difference variance is accounted for by regression on the background variables, excluding the past achievement variables, MATHEXP and GPA; over half the variance is accounted for by regression on the background variables, including MATHEXP and GPA (Chapter 5).

13. At age 17, about half of the mean achievement difference between blacks and whites is accounted for by regression on the background variables, whether or not MATHEXP and GPA are included. As at age 13, the bulk of the reduction in white-black difference is attributable to school-to-school differences in the background variables (Chapter 5).

14. The within-race regression structure, at age 13 and at age 17, is not dramatically different from the regression structure found for the combined samples; the values of R^2 within race tend to be only slightly smaller than those for combined samples (Chapter 5).

15. Both at age 13 and 17, black students in schools that are 90 percent or more white have mean achievement levels considerably higher than those for black students in schools that are 90 percent or more black. The corresponding mean differences for white students appear to be less pronounced (Chapter 5).

16. At age 13, white students in predominantly white schools have a mean score about 1.2 national standard deviations above the mean for black students in predominantly black schools (Chapter 5). This contrasts with a reported corresponding achievement difference of 2 national standard deviations for sixth-grade students in 1965 (Armor, 1972).

This report was largely completed while the first author was a Fellow at the Center for Advanced Study in the Behavioral Sciences, September to December, 1981. We appreciate the assistance of the staff of National Assessment of Educational Progress, Education Commission of the States, who provided the data. We acknowledge helpful advice received from Prof. Lincoln E. Moses, statistical consultant at the Center, and extensive clerical assistance provided by Deanna Dejan and Barbara Witt, word-processing assistants at the Center, and by Cheryl Flynn at The University of North Carolina at Chapel Hill.

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Chapel Hill, N.C.
June, 1982

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Mathematics Achievement Levels of Black and White Youth

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Chapter 1

Educational Trends in the 1970s

The present study provides a detailed description of the mathematics achievement of 13- and 17-year-old black males and black females, compared with white males and white females. The data are from the 1975-76 National Assessment of Educational Progress, based upon probability samples of the nation's youth at ages 13 and 17.

This chapter provides a context for the detailed analysis by reviewing some of the important educational events of the 1970s. The age groups included in our analysis attended school during a time of great social and educational change. They fell heir to the results of the curriculum reforms of the late 1950s. They benefitted from the enormous growth of federal support for civil rights and compensatory education in the middle 1960s. Some participated in court-ordered desegregation plans at various times and places throughout their school years. Many were influenced by the baby-boom crowding of classrooms. Thus, the detailed results from a single school year in the middle of the decade illuminate at one time features of populations we suspect of being in the process of important changes.

The 17-year-olds, born between October 1, 1958, and September 30, 1959, typically entered first grade in the fall of 1965. The typical 17-year-old was in eleventh grade when assessed in the spring of 1976; 86 percent were enrolled in school below the college level (U.S. Bureau of the Census, 1977a). By 1978, 83 percent of this group had graduated from high school (U.S. Bureau of the Census, 1979). The 13-year-olds, born in the calendar year 1962, typically entered first grade in the fall of 1968; most were in eighth grade when assessed in the fall of 1975.[1] Members of this group typically had graduated from high school by 1981. (Census figures are not yet available for this population.)

Just before the 17-year-olds were born, the Russians launched Sputnik, the first space satellite. This triggered concern over the quality of the U.S. educational system and resulted in the National Defense Education Act of 1958, designed to improve mathematics, science and foreign language instruction at all levels. Both the National Science Foundation and the U.S. Office of Education supported the development of new mathematics and science curricula.

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[1] Note that the 17-year-olds were not quite four years older than the 13-year-olds, because of the difference in defined birth date ranges. Because of these age differences and the differences in assessment dates--fall for age 13, spring for age 17--the typical "17-year-old" is three, not four, grades ahead of the average "13-year-old" in this study.

The Civil Rights Act of 1964 was the first significant government monetary support to the civil rights movement. This act initiated the rush of social legislation in the Johnson years. The 13-year-olds were two years old when both the Civil Rights Act and the Economic Opportunity Act were passed; they were among the first children eligible for Project Head Start, which was established by the latter act. The 17-year-olds were in first grade in the year that the Elementary and Secondary Education Act (ESEA) of 1965 was passed.[2]

The 13- and 17-year-old students attended school through the era of court-ordered school desegregation. The Southeastern students were affected first, but even so, the Southeastern 13-year-olds were in grade 3 and the 17-year-olds in grade 6 before any large-scale compliance took place. In the fall of 1969, 70 percent of Southeastern blacks attended grade schools that were at least 90 percent non-white. By 1972, however, only 20 percent attended schools that were 90 percent or more non-white (National Assessment of Educational Progress, 1976b).

The 17-year-olds belonged to the largest birth cohort yet recorded by the census; they were the last of the post-war baby boom. (National Center for Educational Statistics, 1980, p. 63). The 17-year-olds attended school during an era of expanding school budgets. In contrast, the 13-year-olds would later attend high school during a period of decline in expenditures for education as a percentage of gross national product (National Center for Educational Statistics, 1980, pp. 23-24). This decline was probably not entirely due to the decline in school enrollment following the end of the baby boom. The latter half of the seventies witnessed several conservative trends that affected the content as well as the cost of education, a "back to the basics" move in curriculum, an upsurge in minimum competency legislation and a general unwillingness of taxpayers to support the rising cost of government.

However, any conservative trends at the end of the seventies had not influenced these students when they were assessed during the 1975-76 school year. They grew up in an era of expanding educational opportunities for many of those who had been at a disadvantage before--not only blacks, but also other racial and ethnic minorities, women and the handicapped.

High School Graduation

While all these changes in the goals and the influences on education were taking place, changes also were occurring in the outcomes of education. Women and minorities were attending school longer and graduating more frequently.

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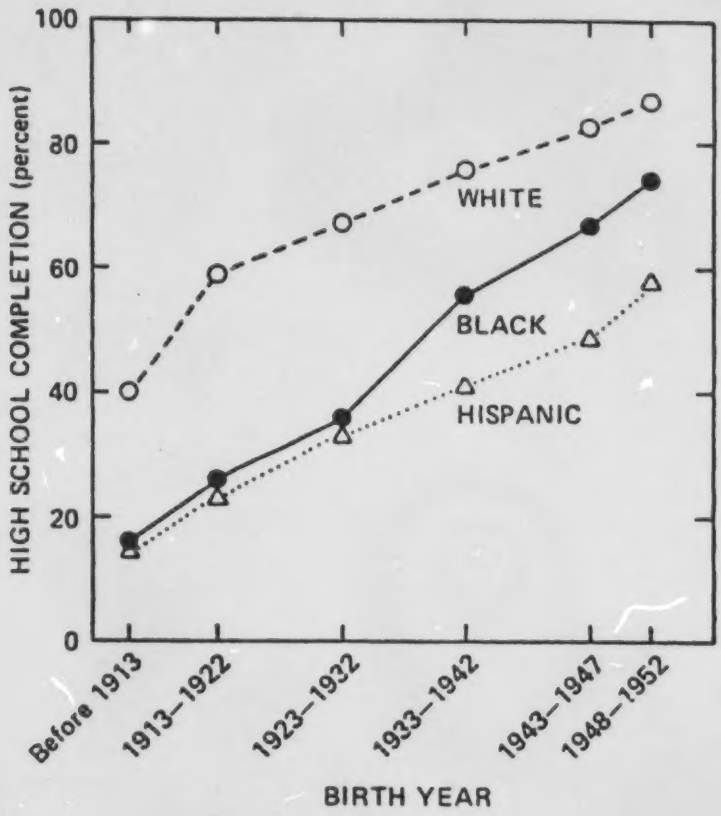
[2] Title I of ESEA provided three quarters of a billion dollars in 1966 to institute educational programs for the children of low-income families. Today, ESEA provides over three billion dollars a year for educationally deprived children (National Center for Educational Statistics, 1980, p. 190). Much of the ESEA money is spent for the purpose of improving the reading and mathematical skills of primary-grade children.

Exhibit 1-1. Percent of persons 25 years old and older in 1977 who had completed high school, by race and birth year.



In the 1920s, fewer than 20 percent of black students graduated from high school compared with about 40 percent of white students. By the mid-1950s, more than 50 percent of black youth graduated; the figure for white students also had increased dramatically, to just under 80 percent. After World War II, the graduation rate grew especially quickly for black youth (Exhibit 1-1 shows graduation rates by year of birth for the nation's white, black and Hispanic citizens over the age of 24 in 1977; data are from U.S. Bureau of the Census, 1977b). A similar accelerated increase in the graduation rate of Hispanic youth appears to have begun in the 1960s. By 1977, 76 percent of black students and 87 percent of white students had completed high school (compared with 58 percent of Hispanics).

When we look at a slightly younger segment of the population--youth between the ages of 20 and 24--a similar but more contemporary picture emerges (Exhibit 1-2; data are from U.S. Commission on Civil Rights, 1978). The reason for choosing this younger age group was well-explained by the U.S. Commission on Civil Rights (1978, pp. 9-16):

> The more common technique has been to base educational attainment statistics on persons 25 years old and over, since they represent an age group which, with few exceptions, has completed its schooling. Although that age range does provide a good basis for calculating trends for long time periods, for the particular purpose of measuring recent trends it is not the most desirable. This is because a large part of the 25-years-and over age group consists of persons who completed their educations decades prior rather than participated in the most recent changes in educational attainment. Furthermore, use of this large age group for comparisons with majority males would tend to exaggerate the inequalities to the extent that recent changes have been beneficial to minorities and women.

For this younger age group, it is clear that the increase in graduation rates for whites is slowing, most likely because they are reaching a ceiling as they approach 90 percent. Meanwhile, the graduation rates for blacks continue to grow at a steady rate for this age group.

During the decade of the seventies, the percentage of blacks taking the College Entrance Examination Board's Scholastic Aptitude Test has risen dramatically (Exhibit 1-3; data are from College Entrance Examination Board, 1981 and earlier editions). However, the population of blacks in high school also has risen. In the first place, the black birth rate was slightly higher than the white in this age range. Second, and more important, the rate of dropping out of high school changed dramatically in the four race by sex groups (Exhibit 1-4; data are from the National Center for Education Statistics, 1980, and earlier editions). Perhaps influenced by the high unemployment rates for black youth, black males have been staying in school in unprecedented numbers. By the year of this study (1976) black and white dropout rates were essentially equal. In more recent years, blacks appear to be dropping out less than whites.

However, even after taking account of the growth of the black high-school population, the representation of black males and females among SAT candidates grew during the seventies. Exhibit 1-5 displays the ratio of the percent of male and female SAT candidates who were black (data are from College Entrance

Exhibit 1-2. Percent of persons 20-24 years old who had completed high school, by race and birth year.

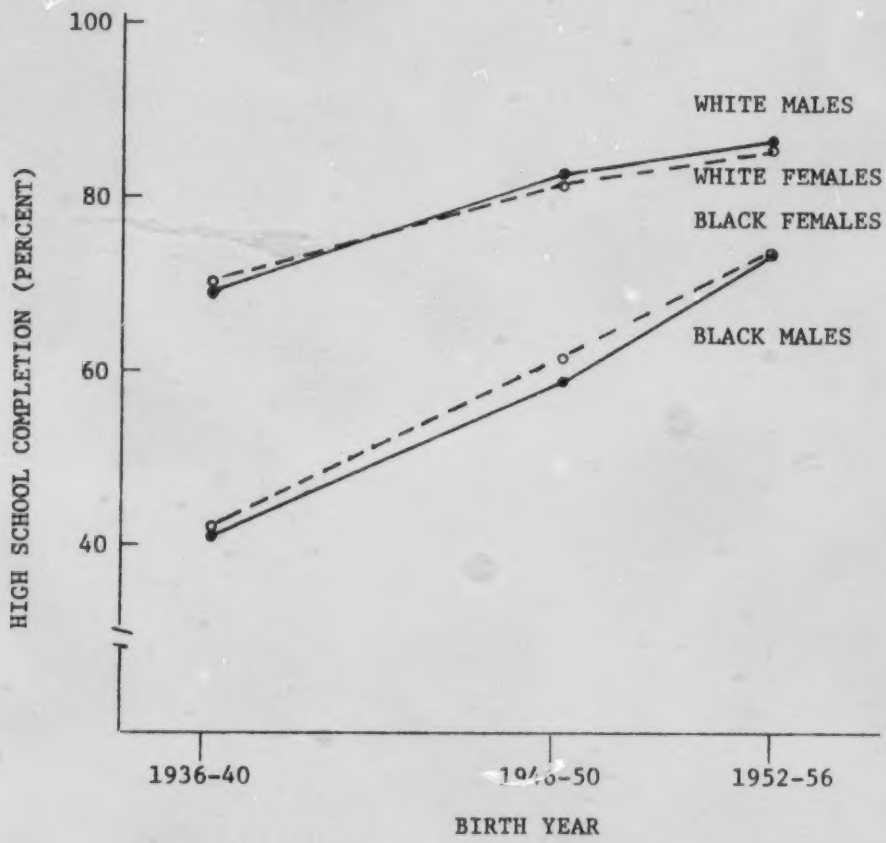
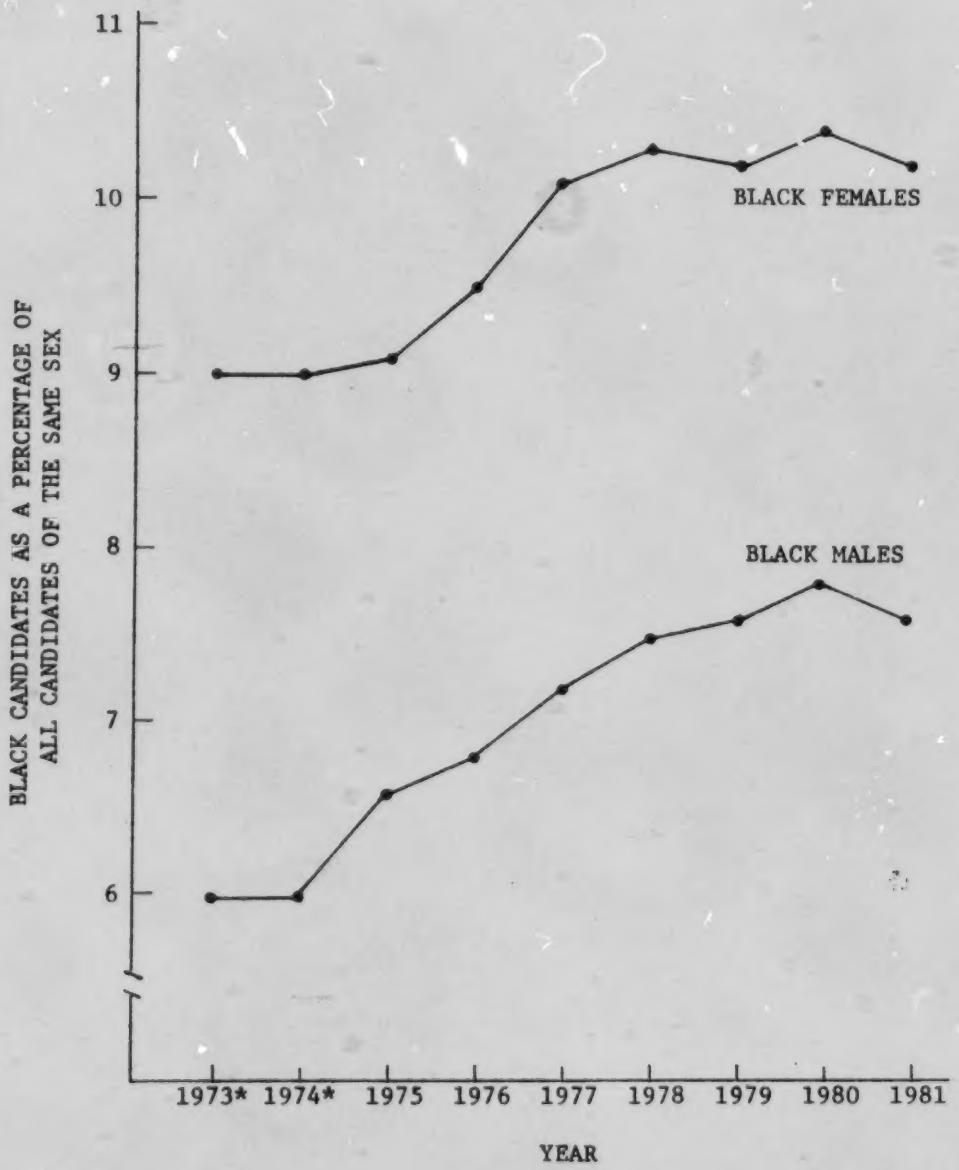
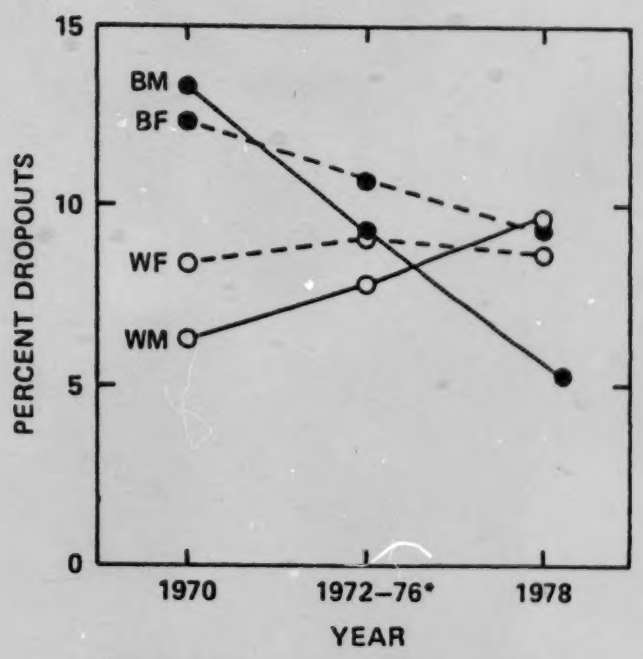


Exhibit 1-3. Percent of SAT candidates who were black, 1973-1981, by sex.



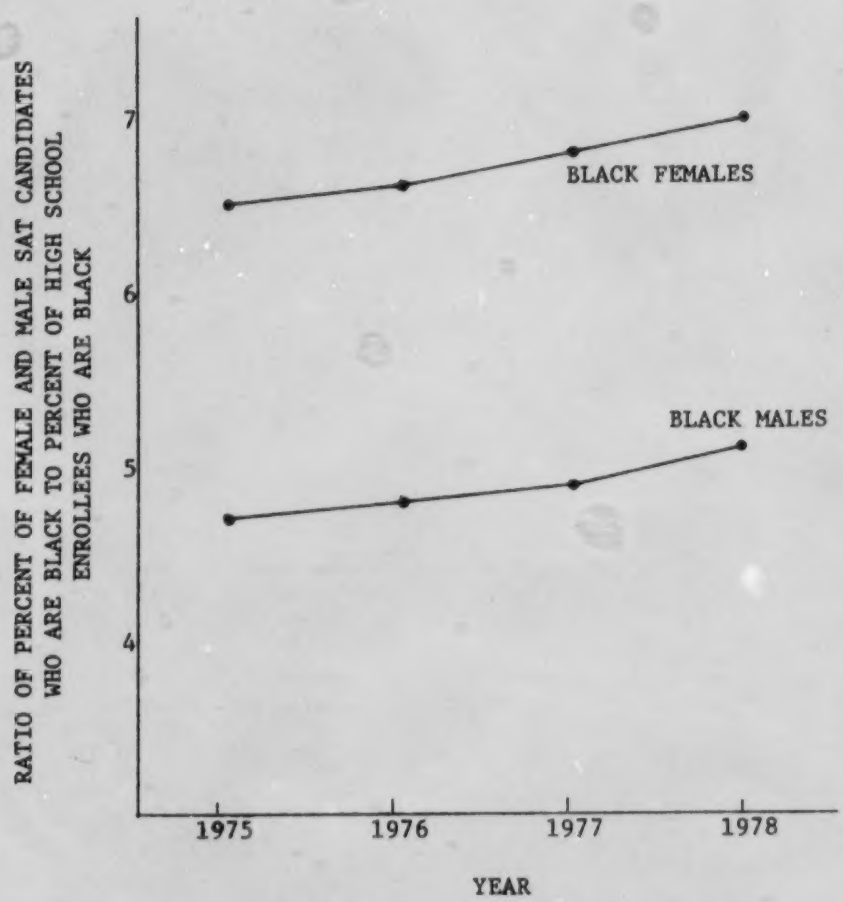
*For 1973 and 1974, data are rounded to the nearest whole percentage.

Exhibit 1-4. Percent of 16-and 17-year-old high school dropouts, 1970 to 1978, by race and sex.



*The median dropout rate for this 5-year period.

Exhibit 1-5. Ratio of black SAT candidates to black high school students, 1975-1978, by sex.



Examination Board, 1978 and earlier editions) to the percent of high school students who were black (data from U.S. Bureau of the Census, 1979, Table 1). A ratio of 1 would represent equity in the sense that the proportion, for example, of black females among SAT takers would then equal the proportion of blacks among high school students. Exhibit 1-5 shows that, between 1975 and 1978, black females rose from 65 percent of equity to 70 percent of equity, while black males rose from 47 percent of equity to 51 percent of equity.

Even while more students were staying in high school, it is not clear that the performance of school children was improving. The decline in college admission test scores from the mid-sixties to the late seventies is well-documented (Beaton et al., 1977; see also L. V. Jones, 1981). These tests are designed to provide a fair comparison of the mathematical and verbal abilities of students from diverse backgrounds. The content is widely taught: e.g., the mathematics content appears in the curriculum by the eighth grade. However, college entrance tests are taken by self-selected subsamples of the student population. Also, the tests are designed to measure the general scholastic abilities presumably needed to succeed in college. They are not intended to measure the kinds of specific information that students need to be good citizens or good workers, or the more fundamental computational and reading skills most called upon in daily living.

The National Assessment of Educational Progress is a more likely source of information about levels of fundamental skill and knowledge and trends over time in educational performance. (The remainder of this chapter is largely from Burton and Jones, 1982a.)

Measures of Achievement

Before considering trends for black and white students separately,[3] it is instructive to look at the trends for the entire population of students. We will confine our discussion to 9- and 13-year old students since those populations are almost completely covered by the National Assessment in-school sample; by age 17, about 10 percent of the students have dropped out of school and another 5 to 10 percent attend so seldom that they are unlikely to be assessed.[4] Given that there have been changes in rate of dropping out by race and sex (Exhibit 1-4, above), it is clear that the in-school 17-year-old population is changing over time and thus that trend results would be difficult to interpret.

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[3] By explicitly attending only to differences between blacks and whites, we do not mean to suggest that any lesser importance attends differences for other minorities. Our attention here is restricted only by the National Assessment samples that provide data on too few Hispanics, American Indians, or other minority groups to allow conclusions to be drawn concerning change in educational achievement.

[4] As initially designed, NAEP samples at age 17 were to be samples of the nation's 17-year-olds, whether or not they were in school. However, budgetary constraints from 1977 onwards necessitated the exclusive sampling in schools at age 17, as at the younger ages, except for special studies, e.g., the 1980-81 assessment of reading.

Exhibit 1-6. Average percent correct for exercises assessed more than once between 1970 and 1980, age 9.

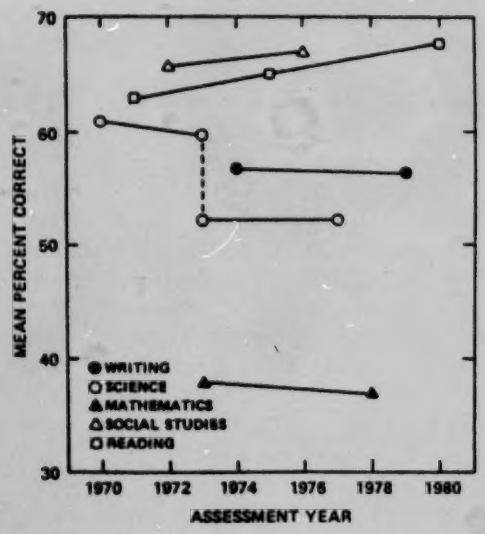
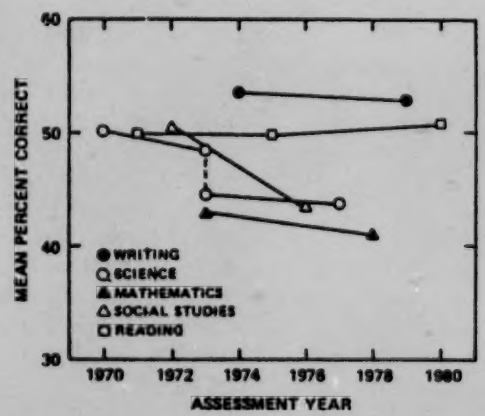


Exhibit 1-7. Average percent correct for exercises assessed more than once between 1970 and 1980, age 13.



National Assessment has calculated, separately for each learning area, the percentage of correct responses to every exercise included in an assessment. National Assessment also averages these percentages over exercises, to reflect mean performance levels for each learning area. Here, to view overall trends, we present the mean percents correct for results over five learning areas that have been assessed more than once (National Assessment of Educational Progress: 1979a, 1979b, 1980a, 1980b, 1981). These five areas--reading, writing, mathematics, science, and social studies--are chosen to represent subjects traditionally central in the school curriculum, and to avoid interpretive difficulties that are peculiar to change data from other areas in National Assessment.[5]

Exhibits 1-6 and 1-7 display the mean percent correct for each assessment in the five learning areas for the nation's 9- or 13-year-olds. Solid lines connect points for sets of items that were identical in two or more years; the dashed lines for science indicate that two different sets of items were administered in 1973, one set identical to 1970 items and the other identical to 1977 items.

At neither age does there appear to be any dramatic overall trend in achievement. At age 9 (Exhibit 1-6), reading skills clearly have improved, and knowledge of social studies may be greater for students in the mid-seventies, compared with earlier in the decade. Science and mathematics skills appear to be slightly less well developed than they were earlier. No clear trend is apparent for writing. At age 13 (Exhibit 1-7) performance declined rather sharply in social studies, declined also in mathematics and in science, and remained essentially unchanged in reading and in writing.

Let us now consider changes over time of differences between white students and black students at ages 9 and 13 (Exhibits 1-8 and 1-9). The national performance level for the five learning areas may have improved, declined, or done some of each, but that national performance level has been subtracted out. Each point shows only the difference between the mean percent correct for whites and the comparable mean percent correct for blacks. Each point on the graph represents a number of exercises and no fewer than 7000 students, of whom at least 800 are black. The standard error of the mean difference is about 1 percentage point.

At age 9 (Exhibit 1-8), the difference levels are seen to be quite similar across learning areas; only writing appears to be markedly more difficult for black children. For the learning areas other than writing, the average difference between white and black 9-year-olds has shrunk from about 17 percentage points to 10 or 11 over the decade of the seventies. At age 13 (Exhibit 1-9) mathematics is relatively the most difficult area for black students. For the areas other than mathematics, means for 13-year-old black students were 17 to 18 points below those for white students in 1970, but only 12 to 13 percentage points below by 1980. A decrease in the difference between white and black students over time is evident at both ages.

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[5] The first cycle for writing is not analyzed here because of interpretive problems having to do with changes in the reporting of writing scores. The other areas assessed more than once by National Assessment are art, citizenship, literature, and music. Emphasis on these subjects varies so much from school to school that we expect black-white differences to be hopelessly confounded with school policy differences in these learning areas.

Exhibit 1-8. Average white-black achievement difference, 1970 to 1980, age 9.

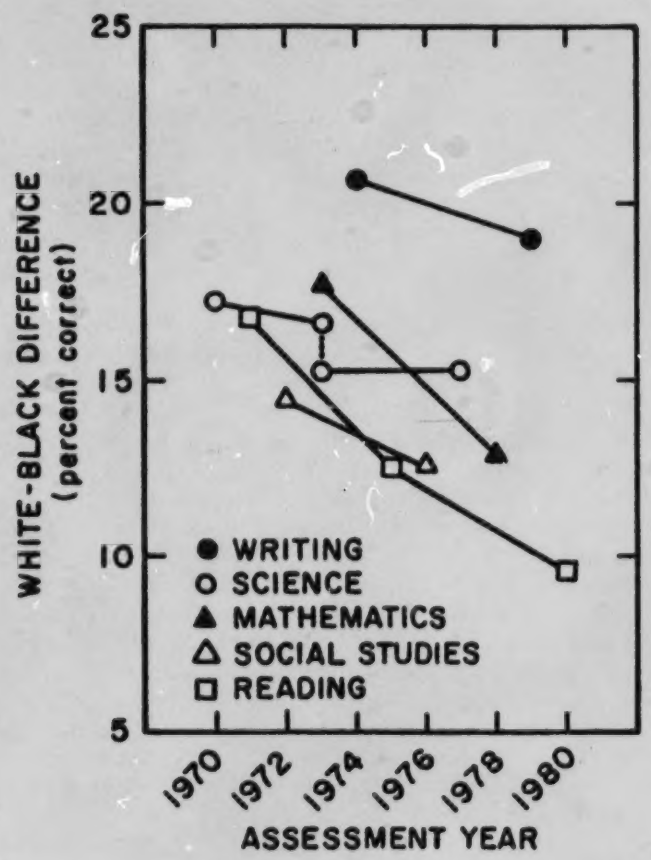


Exhibit 1-9. Average white-black achievement difference, 1970 to 1980, age 13.

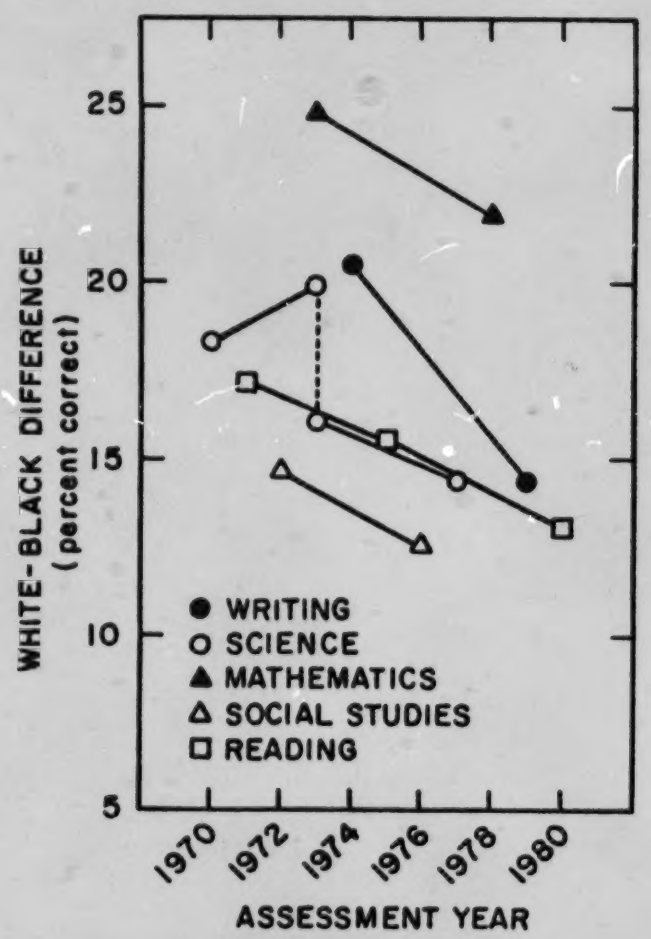
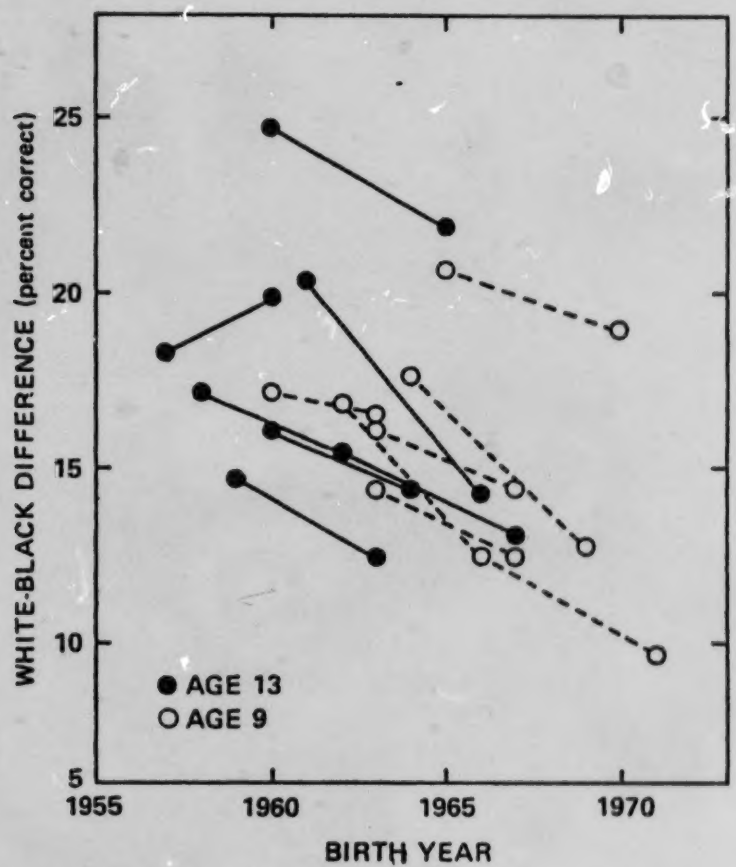


Exhibit 1-10. White-black achievement differences by birth year, 1955-1970.



There is some reason to believe that the improvements for black children at age 9 were not lost as the children became older. The 9-year-old cohort of 1970 was 13 in 1974. Inspection of the 13-year-olds' performance (Exhibit 1-9) suggests that the improvement of 9-year-old black students in the early 1970s may be mirrored at age 13 in the later 1970s.

Exhibit 1-10 presents the white-black difference in performance by year of birth, both for 9- and 13-year olds. In Exhibit 1-10, the data from Exhibit 1-8 are superimposed on the data from Exhibit 1-9. Since the horizontal axis now is year of birth rather than year of assessment, the 9-year-olds' data (white circles) lag behind the 13-year-olds' data (black circles) by four years. There is a rather steady decline in the average white-black achievement difference with advancing year of birth, regardless of learning area or age of assessment.

Whether or not the relative gains in educational achievement of black youth in the 1970s have been accompanied by continued social and economic gains for black families is a matter of some controversy. Freeman (1978) presents compelling evidence that the relative economic position of black Americans did continue to improve up to 1975. Others have argued that political and economic progress for blacks was slowed and, in some cases, reversed during the 1970s (e.g., Hill, 1978; F. C. Jones, 1981). Wilson (1980) presents the case for a growing disparity between "haves" and "have-nots" among black citizens. While the educational, social, and economic benefits to middle-class blacks have improved, the plight of the black poor has worsened. This view is supported by a variety of economic indicators. For instance, between 1969 and 1975, average earnings differentials between whites and blacks declined while, at the same time, differential unemployment and differential poverty rates increased (U.S. Commission on Civil Rights, 1978).

In future years, it would be of interest to discover whether improvements in the relative performance of black youth, observed now at ages 9 and 13, will persist in the population at age 17. Unfortunately, it will not be possible from National Assessment data to determine whether the relative improvement of the black population continues at age 17 unless the out-of-school 17-year-old sample is reintroduced on a regular basis. While the population of 13-year-olds in school is very nearly the same population as 9-year-olds in school four years earlier, school dropouts and early graduates have changed the in-school population by age 17. National Assessment findings at age 17 in school pertain to a more select population than those at the earlier ages. Even more troublesome for comparisons of achievement trends for groups defined by race (or sex), the school dropout rates have differentially changed by race (and sex) over the years since 1970, as shown earlier in Exhibit 1-4.

The achievement results summarized here show that, during the 1970s, the discrepancy in average achievement level between the nation's white and black youth has become smaller in five important learning areas at ages 9 and 13. Typically, when achievement for white students has declined, that for black students has declined less; when whites have improved, blacks have improved more. The difference between the races has decreased at both ages in mathematics, science, reading, writing and social studies. At the same time, the school participation results summarized here indicate that blacks,

particularly black males, are dropping out less; that both male and female blacks are graduating from high school more; and, finally, that more blacks, particularly black females, are applying to selective colleges.

It is of interest to note that attitudes of black students about white students and of white students about black students also may have changed rather markedly between the mid-1960s and the mid- to late-1970s. Moe, Nacoste, and Insko (1981) report on two studies of attitudes of ninth-grade students in a North Carolina junior high school, using the same methods for gathering information in 1966 and in 1979. They present conclusive evidence for a reduction in "social distance" of black students from white students and vice versa. To the extent that this finding is typical of schools, the attitudinal changes may have created an environment in the schools that has been conducive to higher achievement levels for black students.

A number of possible causes have been mentioned, from the rise of a black middle class to the potential effects of desegregation, attitudinal changes, compensatory education, the scientific curriculum movement of the sixties or the back-to-basics movement of the seventies. None of these causal hypotheses can be exclusively established by the present analysis of survey data. However, the overall trends of the seventies can be better understood by the more detailed analysis of the performance differences in mathematics for blacks and whites, males and females, provided by the present study.

Chapter 2

Source of the Data

The National Assessment of Educational Progress (NAEP)

The National Assessment surveys the educational attainments of 9-year-olds, 13-year-olds, 17-year-olds (both in school and early graduates or dropouts) and adults (ages 26-35) in 10 learning areas: art, career and occupational development, citizenship, literature, mathematics, music, reading, science, social studies and writing. Different learning areas are assessed every year, and all areas are periodically reassessed in order to measure change in educational achievement.

Each assessment begins with several years of planning and review by educators, scholars and citizens from all over the country. They must reach a consensus on objectives for each area, proposing specific goals that they feel Americans should be achieving in the course of their education. After careful reviews, these objectives are then given to writers whose task it is to create measurement exercises appropriate to the objectives.

After the exercises have passed extensive reviews by subject-matter specialists and measurement experts, they are administered to probability samples from the several age levels. The people who comprise these samples are chosen in such a way that the results of their assessment can be generalized to the entire national population. That is, on the basis of the performance of about 2,500 13-year-olds on a given exercise, we may generalize about the performance of all 13-year-olds in the nation.[1] Directions and exercises are presented by professional assessment administrators, both in printed booklets and by timed tape recordings. These tape recordings keep administrations uniform, assure that all students are exposed to all items, and help compensate for students' reading difficulties. An "I don't know" response is provided on all items to discourage guessing.

As many as half the exercises assessed each year are published along with the results, to provide the public a specific knowledge of what young Americans know and can do. Objectives are revised and reviewed by new groups of scholars, educators and citizens and new exercises are then developed to replace those published. Each subsequent assessment contains previously-assessed unpublished items to measure trends as well as new items to cover current educational practice.

The Selected Mathematics Assessment

In the 1975-76 assessment of Citizenship/Social Studies, a special mathematics study was added at age 13 and age 17. Special efforts were made

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[1] This description was adapted from a National Assessment report written in 1976 (NAEP, 1976, p. vii). Since then, adults and out-of-school 17-year-olds have been assessed only once. The areas of reading and literature have been combined, as have citizenship and social studies. While legislation mandates that reading, writing and mathematics be reassessed at 5-year intervals, current plans put career and occupational development, music and art on a 10-year reassessment cycle. Beginning in 1981, data will be collected only in alternate years.

to assess all 17-year-olds in school who had been selected for the sample, and out-of-school 17-year-olds --both dropouts and early graduates --also were included. In response to the growing national interest in "basic skills," a subset of mathematics exercises was adapted from the first mathematics assessment (1972-73). The items selected were basic mathematical concepts in a variety of areas--computation, algebra, geometry, logic and measurement. Most of them had been published following the first assessment, and a number were changed from open-ended to multiple-choice format. These exercises were not subject to the usual NAEP process of consensus and review.

Approximately 80 items at each age were allotted to one of two exercise booklets per age. Each exercise booklet took about 50 minutes to administer. A subset of 34 exercises was common to the two ages. Four of the items common to 13-year-olds and 17-year-olds were administered, in identical formats, in both regular national mathematics assessments as well as in the 1976 special study.[2] Another 6 of the common items were administered in an open-ended format in the two regular assessments, but in a multiple-choice format in the special study.

The special 1976 mathematics study differed from the two regular mathematics assessments in intent (selected "basic" concepts versus a general survey of content), in procedure (reuse of published items) and in format (more like a conventional test).[3] Finally, the special mathematics study was administered to larger-than-usual samples. Instead of 2500 respondents per exercise, there were 5000. This doubling of the typical National Assessment sample size permitted the present analysis of such small subpopulations as black males and black females. Exhibit 2-1 summarizes the information about the exercises in the special study. Exhibit 2-2 summarizes the sample sizes for various subgroups.

Adaptations of the Data

The National Assessment data were adapted in three general ways for the purposes of this study of white-black and male-female differences.

Sampling Weights. First, the sampling weights were adjusted using demographic data from the census and from the ten NAEP assessments between 1969 and 1979. The data were divided into the four race by sex cells of interest. Then other demographic variables were evaluated to determine which were associated with substantial variation in the total number of correct answers to mathematics exercises in each of the four race by sex cells. Two influential variables were found to be region of the country and grade in school. The region variable had been collapsed from four levels to two levels because of the relative scarcity of blacks in the Central and Western regions. The two levels of region were Southeast vs. rest. The grade variable was

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[2] The first national mathematics assessment was completed in 1973; the second in 1978.

[3] Contrary to usual Assessment practice, the booklets consisted entirely of multiple-choice mathematics items. Most assessment booklets had previously contained a mixture of learning areas and a mixture of exercise formats.

Exhibit 2-1. Exercises used in the 1976 selected mathematics study.

	Age 13		Age 17	
	*Exercise Sample 1	Exercise Sample 2	Exercise Sample 1	Exercise Sample 2
Total exercises	42	46	43	40
Subsets of exercises:				
Identical at ages 13 and 17	16	18	16	18
Identical also in 2 regular assessments	4	0	4	0
Open-ended in 2 regular assessments	3	3	3	3

*'Exercise sample' is used in preference to 'exercise booklet' to emphasize that each booklet contains a separate sample of exercises and is administered to a separate probability sample of the age population.

Exhibit 2-2. Sample sizes in the 1976 selected mathematics study, by race and sex.

	Age 13		Age 17			
			In school		Out of school*	
	Exercise Sample 1	Exercise Sample 2	Exercise Sample 1	Exercise Sample 2	Exericse Sample 1	Exercise Sample 2
Blacks						
Females	325	335	274	284	29	20
Males	294	312	242	248	10	19
Both sexes	619	647	516	532	39	39
Hispanics						
Females	139	142	92	86	1	6
Males	134	152	130	109	9	7
Both sexes	273	294	222	195	10	13
Whites						
Females	1962	1851	2162	2091	100	20
Males	1984	1951	1946	2034	93	84
Both sexes	3946	3802	4108	4125	193	204
Totals						
Females	2426	2328	2528	2461	130	146
Males	2412	2415	2318	2391	112	110
Both sexes	4838	4743	4846	4852	242	56

*The size of the out-of-school sample was not doubled.

Exhibit 2-3. Estimated proportion, by sample, race, and sex, of all blacks and whites in the population.

Age 13

	Sample 1			Sample 2		
	Female	Male	Both	Female	Male	Both
Black	7.3	6.4	13.7	7.3	6.4	13.7
White	42.9	43.4	86.3	42.9	43.4	86.3
Both	50.24	49.8	100.0	50.2	49.8	100.0

Age 17

Race	Female	Male	Both	Female	Male	Both
Black	6.6	5.2	11.8	6.3	5.4	11.7
White	44.7	43.5	88.2	45.1	43.2	88.3
Both	51.3	48.7	100.0	51.4	48.6	100.0

Exhibit 2-4. Description of major background variables.

Variable	No. of levels	Description of levels
Race	2	Black, white
Sex	2	Female, male
Region*	2	Southeast vs. Northeast + Central + West
Type of community (TOC)*	4	Inner City (10% of sample), Extreme Rural (10% of sample), Rest (70% of sample: residual category), High Metro (10% of sample)
Parents' occupation (OCC)	4	Based on school principal's report of the percent of parents who are professional (P) and the percent on welfare (W). OCC = P - W; -100 to -11; -10 to -1; 0 to 10, and 11 to 100.
Grade (age 13)	2	Students below grade 8 vs. students in grade 8 or higher.
Grade (age 17)	4	Dropouts; students below grade 11; students in grade 11; students in grade 12 and graduates.
Parents' highest education (PED)	4	Students who did not know either parents' level of education; students who reported that neither parent had gone beyond high school; students who provided no response (typically because the question was not asked in this school); students who reported that one or both parents had gone beyond high school. As reported by student.
Printed materials in the home (FAMSUM)	5	Sum, from 0 to 4, of the following items in the home: regular newspaper, regular magazines, 25 or more books, encyclopedia. As reported by student.
Variables available only at Age 17		
GRADAV	8	Self-reported grade average from D- to A.
Math classes taken (MATHEXP)	4	Sum, from 0 to 3, of the following courses: First-year Algebra, Second-year Algebra, Geometry, as reported by student.

*See NAEP (1979b, pp. 17-19) for a complete definition of these variables.

also collapsed to two levels: those in or above the modal grade for the age vs. those below the modal grade. For whites (except whites below modal grade in the Southeast) sample sizes were large enough to allow further stratification on the educational level of the parents. Stable estimates of the population sizes in these race x sex x region x grade x parental education also collapsed to two levels: those in or above the modal grade for the age strata were found, using census data as well as sampling information from ten years of the National Assessment. This fine-tuning of population-size estimates should increase the accuracy of the race and sex performance estimates. Exhibit 2-3 shows the results of utilizing the sampling weights to estimate the proportion of blacks and whites in the population that falls into each race by sex cell, for each age and each sample. (See Burton and Jones, 1982b, for a more complete description of the weight adjustment study.)

Background Variables. Our second adaptation of the data was simply to analyze some of the variables not traditionally included in National Assessment reports. A description of the variables included in major analyses is given in Exhibit 2-4. Results based upon the use of these variables will be discussed in subsequent chapters. Our plan for choosing variables to analyze involved exploring relations with mathematics achievement in one of the two samples of exercises at each age--Sample 1--and cross-validating on Sample 2. Variables showing relations that were confirmed in cross-validation have been retained.

Scaling the Exercises. In the third and most major adaptation of the National Assessment data, we scaled the correct answers to the mathematics exercises in several ways. National Assessment never develops psychometric scales, i.e., "test scores." An assessment may be characterized as a collection of quasi-independent indicators in some area of educational interest. The area of interest may or may not coincide with a dimension of individual ability. The reading assessment probably subsumes both a curriculum area and a definable mental ability. In contrast, social studies is a curriculumm domain that does not coincide with any single mental trait. Adding together correct answers to assessment exercises often lead to an uninterpretable total; National Assessment rarely does it.

We explored various ways of summarizing the National Assessment data: average percent correct; arcsine of proportion correct; difference scores involving either the percent correct (p) or the arcsine; sum of correct answers adjusted for random guessing; and various kinds of factor scores. The results of some of these scaling efforts are discussed in later chapters. For most analyses, the percent of exercises answered correctly by each individual was found to be an adequate summary score.

Because summary scores were to be used, a small number of respondents with incomplete records were discarded. These included respondents who were not exposed to all items because of administrative mishaps (e.g., fire drills), as well as students who did not respond or responded "I don't know" to long sequences of items. Respondents with large numbers of "I don't know" or blank responses were not automatically discarded. Respondents were retained if they periodically made a substantive response throughout the set of exercises. Sample sizes of discarded respondents are summarized in Exhibit 2-5. Summaries and scales that proved useful on cross-validation are described in later chapters.

Exhibit 2-5. Respondents discarded due to incomplete records.

Number of Respondents	Age 13		Age 17	
	Sample 1	Sample 2	Sample 1	Sample 2
Total	4969	4958	5268	5324
Discarded	14	76	77	130
Percent discarded	0.34	1.53	1.46	2.44

Chapter 3

Group Differences in Mathematics Achievement

In the 1975-76 mathematics assessment, national samples of students responded to sets of 40 or more mathematics exercises. At age 13, 42 exercises were administered to one national sample of 5000 students and 46 exercises were administered to a second sample of 5000 students. At age 17, 43 exercises were administered to one national sample and 40 exercises were administered to a second sample; again, each sample included about 5000 students. This special mathematics assessment differs from most previous national assessments in two ways: the sample of students is twice as large as usual for each exercise, and each student was given an entire set of exercises on one subject, mathematics.

From the data in this assessment, we constuct a mathematics achievement score for each student. This score, the percent of exercises answered correctly, is based on different exercises for each of the four age-sample groups.

Every student has been assigned a sampling weight to reflect the size of the population represented by that student. (See Burton and Jones, 1982b, Moore et al, 1974, and Chapter 2 for descriptions of the methods used to assign sampling weights.) All statistics presented here are computed using the sampling weights. The statistics thus serve as estimates of population characteristics.

For each sample at each age, we shall report the weighted mean and the weighted standard deviation of mathematics scores (percent correct), separately for black females, black males, white females, and white males. We also estimate standard errors for these means, by weighted half-sample replication procedures (McCarthy, 1969; Frankel, 1971; Lee, 1972), tailored to the NAEP sampling design. In addition, we report means, standard deviations, and standard errors of the mean percent correct for those 16 exercises in Sample 1 and 18 exercises in Sample 2 that were administered both at ages 13 and 17, to yield information about possible differential growth in mathematics knowledge over the high school years for the four race-sex groups.

All Exercises

Age 13

Exhibit 3-1 displays for age 13, Sample 1, the following statistics:

- %w: the estimated relative population size; that is, the percentage of the national population (but excluding Hispanics and students of "other" races) estimated, by sampling weights, to fall into each of the displayed groups.
- M: the mean mathematics score; that is, mean percent of items answered correctly by each of the displayed groups.
- s: the standard deviation of mathematics scores for each of the displayed groups.

Exhibit 3-1. Summary data, 42 exercises at age 13, Sample 1.

Statistic	Race	Sex		
		Female	Male	Both sexes
Estimated relative population size, z_w	B	7.3	6.4	13.7
	W	42.9	43.4	86.3
	Both races	50.2	49.8	100.0
Mean mathematics score, M	B	53.4	50.8	52.2
	W	70.5	70.5	70.5
	Both races	68.0	68.0	68.0
Standard deviation, s	B	15.6	16.8	
	W	15.5	17.4	
Pooled within-group standard deviation,		s_w =		16.4
Standard error of the mean, s_M	B	1.8	2.3	
	W	.72	.75	

Exhibit 3-2. Summary data, 46 exercises at age 13, Sample 2.

Statistic	Race	Sex		
		Female	Male	Both sexes
Estimated relative population size, %w	B	7.3	6.4	13.7
	W	42.9	43.4	86.3
	Both races	50.2	49.8	100.0
Mean mathematics score, M	B	57.4	56.5	57.0
	W	72.8	73.6	73.2
	Both races	70.6	71.4	71.0
Standard deviation, s	B	15.5	15.6	
	W	14.5	15.6	
Pooled within-group standard deviation,			s_w =	15.1
Standard error of the mean, s_M	B	2.2	1.6	
	W	.82	.59	

s_w: the pooled within-group standard deviation; that is, the standard deviation computed by averaging the variances for the four race-sex groups.

s_M: the standard error of the mean mathematics score.

Exhibit 3-2 shows the same results for age 13, Sample 2.

The female-male difference in mean mathematics score is negligible at age 13; the sex difference is significantly different from zero neither for blacks nor for whites for either sample.

Within both sexes, the mean difference by race at age 13 is highly significant, both for Samples 1 and 2. The mean difference in favor of whites at age 13, Sample 1, is about 18 percentage points, approximately 1.1 times the pooled within-group standard deviation of 16.4. For Sample 2, it is about 17 percent, again about 1.1 times s_w (15.1 percent).

It is of interest to compare the variability in achievement scores for the race-sex groups. Assuming normally distributed achievement scores, an appropriate test of the significance of the difference in variability of two samples is to refer the variance ratio s_a^2/s_b^2 to the F distribution, with n_a and n_b degrees of freedom. If we arbitrarily assign the larger variance to the numerator of this ratio, then the nominal probability value from the F distribution must be doubled. It will be recalled that the approximate sample sizes from which our statistics are estimated are about 2000 each for white females and white males and about 300 each for black females and black males. The sampling design, however, is such that these are not simple random samples. The degrees of freedom associated with each is judged to be about one-half the actual sample size. Taking a conservative stance, we shall use degrees of freedom of 900 for each of the white samples and 120 for each of the black samples, and we shall attend only to differences in variance that are significant beyond the .025 level.[1]

For Sample 1, the ratio of variance estimates for black males and black females is 1.16, not significantly different from 1.00 with degrees of freedom 120 and 120. The ratio of variance estimates for white males and white females 1.26, is significant at the .001 level with degrees of freedom 900 and 900. For Sample 2, the variance ratio, white males to white females, 1.16, is significant at the .025 level. No other variance ratio approaches significance.

We conclude that the variance in achievement scores is larger for white males than white females at age 13.

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1 A more exact approach would be to utilize fourth moments of the distributions in the evaluation for significance, to guard against non-normality. See Box, 1953.

Exhibit 3-3. Summary data, 43 exercises at age 17, Sample 1.

Statistic	Race	Sex		
		Female	Male	Both sexes
Estimated relative population size, %w	B	6.6	5.2	11.8
	W	44.7	43.5	88.2
	Both races	51.3	48.7	100.0
Mean mathematics score, M	B	38.6	44.6	41.2
	W	66.1	70.7	68.4
	Both races	62.6	67.9	65.2
Standard deviation, s	B	16.7	19.3	
	W	20.4	20.4	
Pooled within-group standard deviation,		s_w =		20.1
Standard error of the mean, s_M	B	1.6	2.1	
	W	.81	.54	

Exhibit 3-4. Summary data, 40 exercises at age 17, Sample 2.

Statistic	Race	Sex: Female	Sex: Male	Sex: Both sexes
Estimated relative population size, %w	B	6.2	5.4	11.7
	W	45.1	43.2	88.3
	Both races	51.4	48.6	100.0
Mean mathematics score, M	B	44.6	47.3	45.9
	W	66.9	71.1	69.0
	Both races	64.2	68.5	66.3
Standard deviation, s	B	16.1	19.1	
	W	16.7	17.4	
Pooled within-group standard deviation,		s_w =		17.0
Standard error of the mean, s_M	B	1.6	2.3	
	W	.44	.40	

Age 17

Exhibits 3-3 and 3-4 present results for age 17 comparable to those of Exhibits 3-1 and 3-2 for age 13.

At age 17, Sample 1 (Exhibit 3-3), males of both races achieve higher mean mathematics scores than females, and the sex difference is significant beyond the .01 level for both races. (For blacks, $M_F - M_M = -6.0$, with a standard error of 2.6; for whites, $M_F - M_M = -4.6$, with a standard error of 1.0). For Sample 2 (Exhibit 3-4), males of both races perform at a higher level than females, with mean percent correct 2.7 percentage points higher than females for blacks (nonsignificantly different from zero, given the standard error of the mean difference, 2.8) and 4.2 percentage points higher than females for whites (highly significant, given the standard error of the mean difference, .6). The mean difference between whites and blacks at age 17 is substantial in both samples. For Sample 1, the mean difference of 27 percentage points is about 1.4 times the pooled within-group standard deviation of 20.1. For Sample 2, the mean difference between percent correct for whites and blacks, 23 percentage points, is again about 1.4 times s_w (17.0 percent).

At age 17, variance estimates are compared by an F-test, as was done at age 13. It is found for Sample 1 that the ratio of the variance for white females to that for black females, 1.49, is significant at the .01 level. No comparable difference is found for Sample 2, and no other within-sex or within-race variance comparisons approach significance.

Summary of Findings for All Exercises

Samples 1 and 2 provide a consistent portrayal of race and sex differences in mathematics achievement at ages 13 and 17.

(1) At age 13, for neither race is there found to be evidence of mean sex differences in mathematics achievement.

(2) For both blacks and whites, the mean for 17-year-old males is slightly higher than that for 17-year-old females, typically by about one-quarter of the within-group standard deviation.

(3) At age 13, the mean performance of whites is higher than that of blacks by about 1.1 times the within-group standard deviation.

(4) The mean performance difference associated with race is larger at age 17, growing to about 1.4 times the within-group standard deviation.

(5) There is a tendency, better marked at age 13 than at age 17, for variability of scores to be greater for males than for females.

The combined results from Samples 1 and 2 are consistent with an additive model of achievement on the mathematics exercises, with a parameter for race and a parameter for sex. I.e., we may express the deviation (D) from the overall mean percent correct for each of the four race-sex cells in terms of two additive parameters,

$$D = r_i + s_j \qquad (3.1)$$

At age 13, for whites, $r_i = 2$, and for blacks, $r_j = -15$. At age 13, for both males and females, $s_j = 0$. At age 17, for whites, $r_i = 3$, and for blacks, $r_i = -22$. At age 17, for males, $s_j = 2$, while for females, $s_j = -2$. (Were the two race groups of equal size in the population, the race effects, r_i, at each age would be of equal magnitude but opposite sign.) This simple model produces results, both for Samples 1 and 2, that are consistent with the observed cell means, i.e., results that fall within ± 2 standard errors of the observed mean values. The fact that an additive model applies shows that a single effect for race plus a single effect for sex accounts for all the results displayed. There is no extra disadvantage associated with being both black and female; no extra advantage for being both white and male.

Exercises Common to Ages 13 and 17

Exhibits 3-5 and 3-6 display for ages 13 and 17, respectively, for that subset of 16 mathematics exercises that was administered both to age 13, Sample 1, and to age 17, Sample 1, the same statistics as those presented for all mathematics exercises in Exhibits 3-1 to 3-4. Exhibits 3-7 and 3-8 present the same results for the 18 exercises common to age 13, Sample 2, and age 17, Sample 2. The key results from these exhibits appear as graphs in Exhibits 3-9 and 3-10. The graphs show mean mathematics achievement subscores (percent correct) for each race-sex group, with vertical bar drawn to represent a one-standard-error range above and below each mean.

A comparison of results in Exhibits 3-9 and 3-10 suggests that the results from Samples 1 and 2 are not identical, particularly with respect to female-male mean differences. For the 18 exercises common to age 13, Sample 2, and age 17, Sample 2, the males at both ages perform at higher levels, relative to females, than for the 16 exercises common to age 13, Sample 1. This probably reflects some differences in content between the two sets of exercises.

Exhibit 3-5. Summary data, 16 exercises at age 13, Sample 1.

Statistic	Race	Sex		
		Female	Male	Both sexes
Estimated relative population size, %w	B	7.3	6.3	13.7
	W	42.9	43.4	86.3
	Both races	50.2	49.8	100.0
Mean mathematics score, M	B	49.4	46.2	47.9
	W	67.2	66.9	67.0
	Both races	64.6	64.2	64.4
Standard deviation, s	B	18.0	19.1	
	W	18.8	21.0	
Pooled within-group standard deviation,		s_w =	20.1	
Standard error of the mean, s_M	B	2.0	2.7	
	W	.89	.81	

Exhibit 3-6. Summary data, 16 exercises at age 17, Sample 1.

Statistic	Race	Sex		
		Female	Male	Both sexes
Estimated relative population size, %w	B	6.6	5.2	11.8
	W	44.7	43.5	88.1
	Both races	51.2	48.7	100.0
Mean mathematics score, M	B	50.8	54.8	52.6
	W	79.4	81.8	80.6
	Both races	75.7	78.9	77.3
Standard deviation, s	B	20.4	23.0	
	W	19.0	18.6	
Pooled within-group standard deviation,		s_w =	19.0	
Standard error of the mean, s_M	B	2.6	2.5	
	W	.68	.50	

Exhibit 3-7. Summary data, 18 exercises at age 13, Sample 2.

Statistic	Race	Sex: Female	Sex: Male	Sex: Both sexes
Estimated relative population size, %w	B	7.3	6.4	13.7
	W	42.9	43.4	86.3
	Both races	50.2	49.8	100.0
Mean mathematics score, M	B	39.3	40.2	39.7
	W	57.7	60.8	59.3
	Both races	55.0	58.1	56.5
Standard deviation, s	B	16.6	17.1	
	W	18.8	20.1	
Pooled within-group standard deviation,		s_w =		19.1
Standard error of the mean, s_M	B	1.9	1.6	
	W	.90	.71	

Exhibit 3-8. Summary data, 18 exercises at age 17, Sample 2.

Statistic	Race	Sex		
		Female	Male	Both sexes
Estimated relative population size, %w	B	6.2	5.4	11.7
	W	45.1	43.2	88.3
	Both races	51.4	48.6	100.0
Mean mathematics score, M	B	45.7	50.2	47.8
	W	68.9	75.2	72.0
	Both races	66.1	72.4	69.1
Standard deviation, s	B	17.9	21.0	
	W	18.2	18.3	
Pooled within-group standard deviation,		s_w =		18.4
Standard error of the mean, s_M	B	1.8	2.6	
	W	.52	.46	

Exhibits 3-11 and 3-12 present for common-item subscores the mean differences between ages 13 and 17 for the four race-sex groups. For black females, the mean for 17-year-olds is only slightly higher than that for 13-year-olds, 1.4 percentage points for Sample 1 and 6.4 percentage points for Sample 2. For black males, the means at age 17 are 9 to 10 points higher than those at age 13. White female 17-year-olds perform at a mean level 11 to 12 percentage points higher than female 13-year-olds, and the comparable growth[2] for white males is 14 to 15 points. Except for black females, Sample 1, all estimates of growth in achievement are significantly greater than zero.

Combined results are consistent (within bounds of ± 2 standard errors) with an additive model of growth (G) in mathematics achievement subscores from age 13 to age 17:

$$G = 13 + r_i + s_j, \qquad (3.2)$$

where r_i is 13 for whites, 6 for blacks, and s_j is 2 for males, -2 for females. The scale is growth in average percent correct for the exercises common to both ages.

Findings for each of the two sets of exercises common to ages 13 and 17 are telling essentially the same story.

(1) At age 13, there is no appreciable mean difference between females and males.

(2) At age 17, the means for males are modestly higher than the means for females.

(3) At age 13, the mean performance for whites is higher than that for blacks, by about one within-group standard deviation.

(4) At age 17, the difference between the mean performance of whites and blacks has increased to about 1.4 times the within-group standard deviation.

(5) The difference between performance at age 17 and age 13 is greater for whites (13 percent) than for blacks (6 percent) and is greater for males (15 percent) than for females (11 percent).

Q-Q Plots

We now have compared means and standard deviations of achievement scores for black and white female and male students at ages 13 and 17. A means for comparing sample distributions of scores is provided by the Q-Q plot, a plot of the inverse cumulative distribution of scores for one group against that

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[2] These are synthetic estimates of growth, since the 13-and 17-year-olds are different subjects assessed at the same time, rather than the same subjects, assessed first at age 13 and then again at 17.

Exhibit 3-9. Mean mathematices subscores by race and sex for 16 exercises administered to ages 13 and 17, Sample 1.

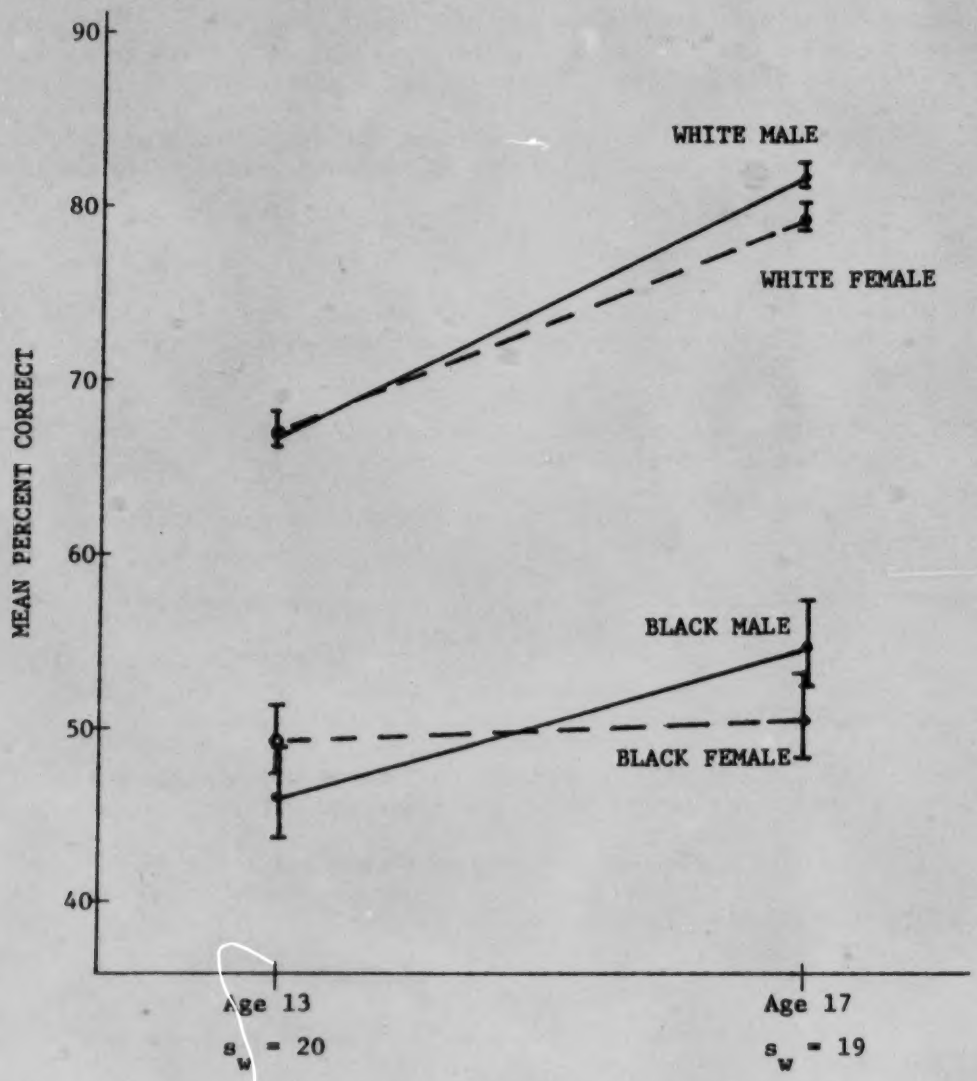


Exhibit 3-10. Mean mathematics subscores by race and sex for 18 exercises administered to ages 13 and 17, Sample 2.

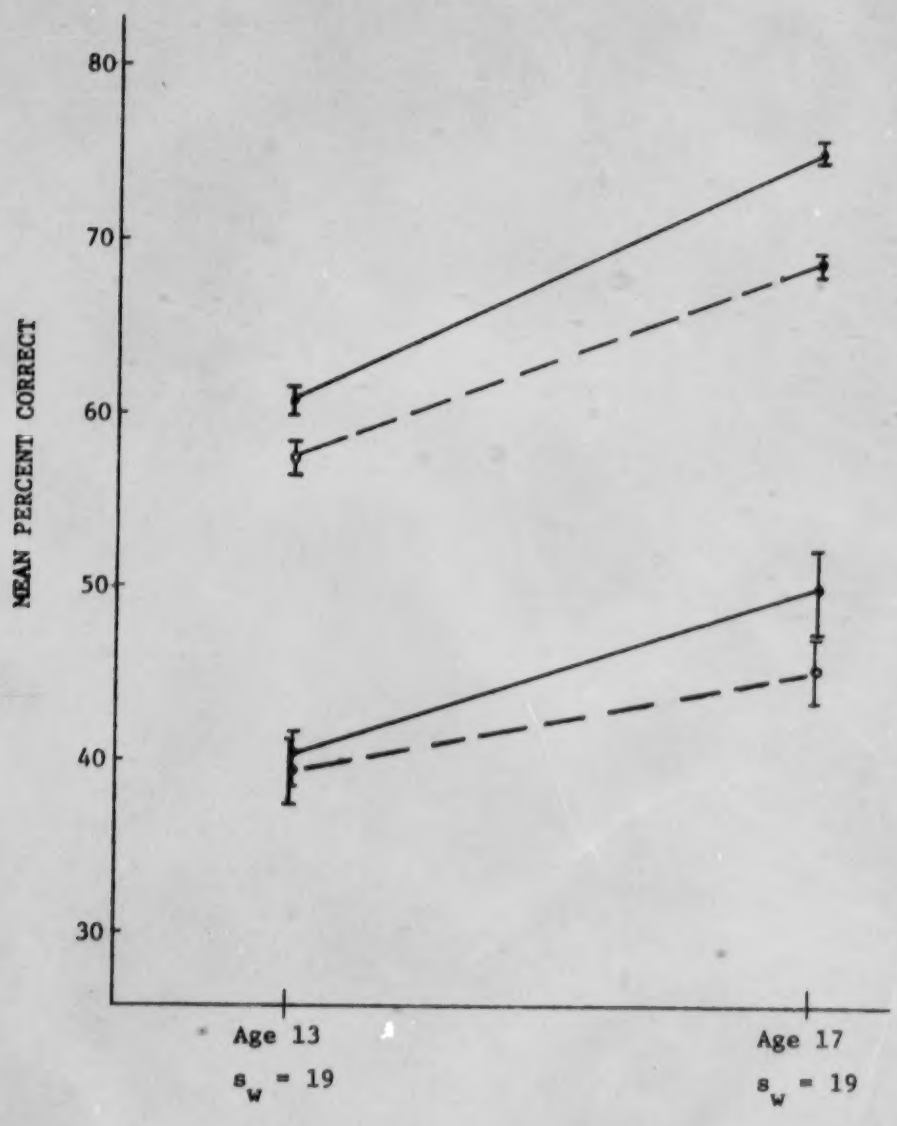


Exhibit 3-11. Difference between mean subscores for age 17 and age 13 on 16 exercises common to both ages in Sample 1.

Statistic	Race	Sex		
		Female	Male	Both sexes
$M_{17} - M_{13}$	B	1.4	8.6	4.7
	W	12.2	14.9	13.6
	Both races	11.1	14.7	12.9
Standard error	B	3.3	3.7	
	W	1.1	.95	

Exhibit 3-12. Difference between mean subscores for age 17 and age 13 on 16 exercises common to both ages in Sample 1.

Statistic	Race	Sex		
		Female	Male	Both sexes
$M_{17} - M_{13}$	B	6.4	10.0	8.1
	W	11.2	14.4	12.7
	Both races	11.1	14.3	12.6
Standard error	B	2.7	3.1	
	W	1.0	.85	

for another (Gnanadesikan, 1977, pp. 198-199). The plot is presented in quantile units, e.g., deciles or percentiles. If two sample distributions are identical, the plot of the quantiles of one distribution against the quantiles of the other will form a straight line with unit slope, passing through all sample points (x,x). If the two distributions differ only in location, the plot will remain linear with unit slope, but the line of relation will be translated upwards or downwards. If the two distributions differ only in scale, the line will remain linear, will pass through point defined by the two sample medians, but the slope will be other than unity. Other distributional differences, e.g., differential skewness or kurtosis, will be reflected by nonlinearity of the Q-Q plot.

Age 13

For age 13, Sample 1, we present Q-Q plots with 20 points obtained by dividing the samples into quantile intervals of .05, using sampling weights, for the distributions of proportion of correct answers for black females vs. black males (Exhibit 3-13), white females vs. white males (Exhibit 3-14), black females vs. white females (Exhibit 3-15), and black males vs. white males (Exhibit 3-16). (Corresponding Q-Q plots for Sample 2 are almost indistinguishable from those of Sample 1, and are not presented here.) Each "2" is plotted at the point (x_{2i}, x_{1i}), where i takes on the quantile values .05k, k=1,2,...20. The three circles on each plot define a line of unit shape, passing through the origin.

Exhibit 3-13, comparing the distribution of achievement scores at age 13 for black females with black males, shows the black females to have the higher median. (We saw in Exhibit 3-1 that they also have the higher mean.) The median for black females is 50.9 percent correct, while that for black males is 48.5. It also is apparent from Exhibit 3-13 that the highest scoring black males attain higher scores than the highest scoring black females. The 95th percentile for black females is 79.7 percent correct, but for black males is 82.5 percent correct. On the other hand, more black females than black males attain moderately high scores. The black females have a higher median (and mean) score, but fewer of them display scores at the highest levels, a fact made clear by the Q-Q plot but not evident from the sample means and standard deviations of Exhibit 3-1.

In Exhibit 3-14, the Q-Q plot comparing scores of white females with those of white males at age 13, we detect no difference in central tendency--the medians are 71.1 for the white females, 72.1 for the white males--but there is evidence of lower variability for the females, since the slope of the Q-Q plot appears to be less than unity. This is consistent with the evidence from Exhibit 3-1 that the white female scores have a smaller standard deviation than the white male scores. The Q-Q plot reveals the main difference to be that females have higher scores than males at the low end of the distributions.

Exhibit 3-13. Q-Q plot, proportion of exercises answered correctly by black females vs. proportion answered correctly by black males, age 13, Sample 1.

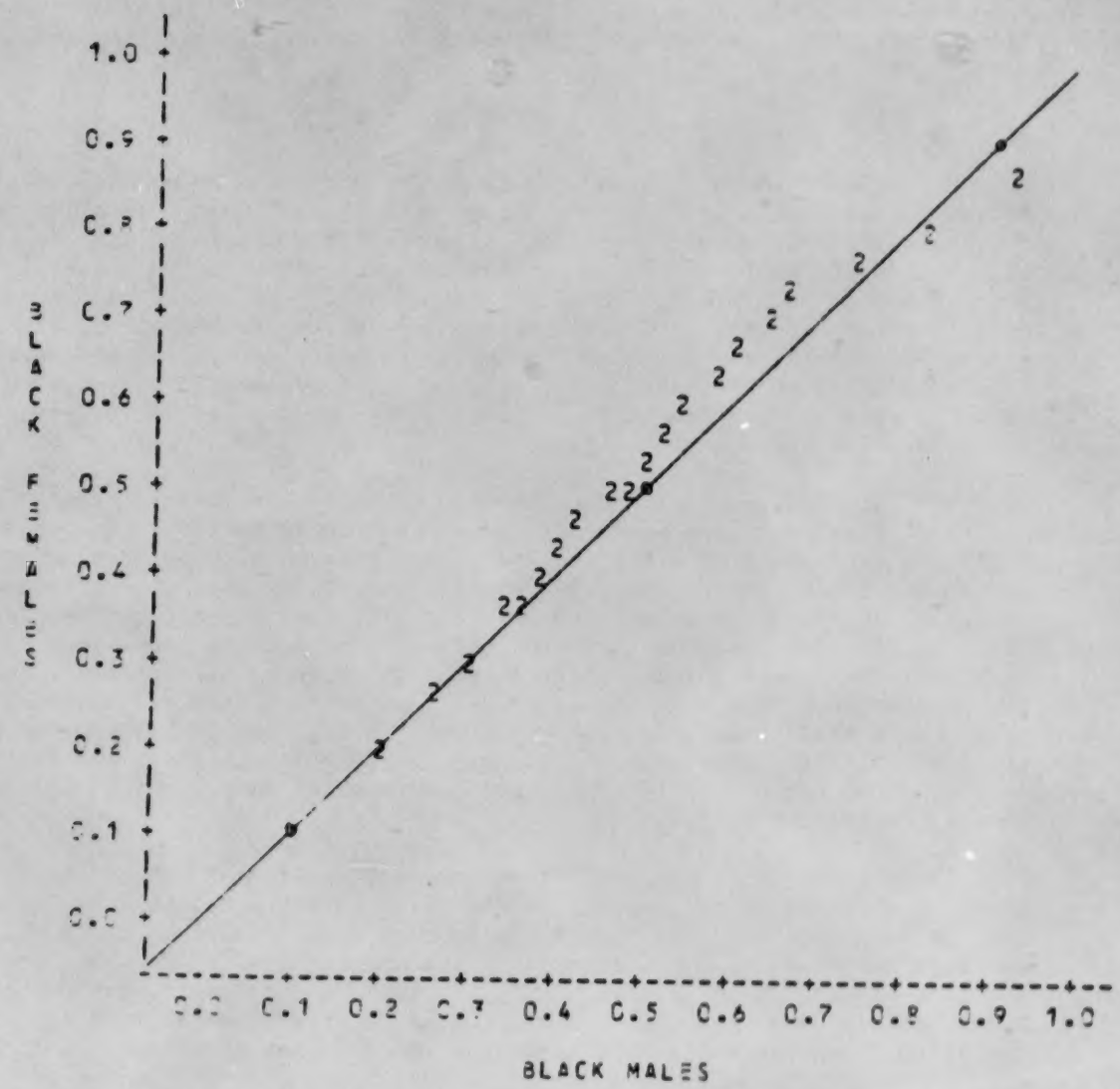


Exhibit 3-14. Q-Q plot, proportion of exercises answered correctly by white females vs. proportion answered correctly by white males, age 3, Sample 1.

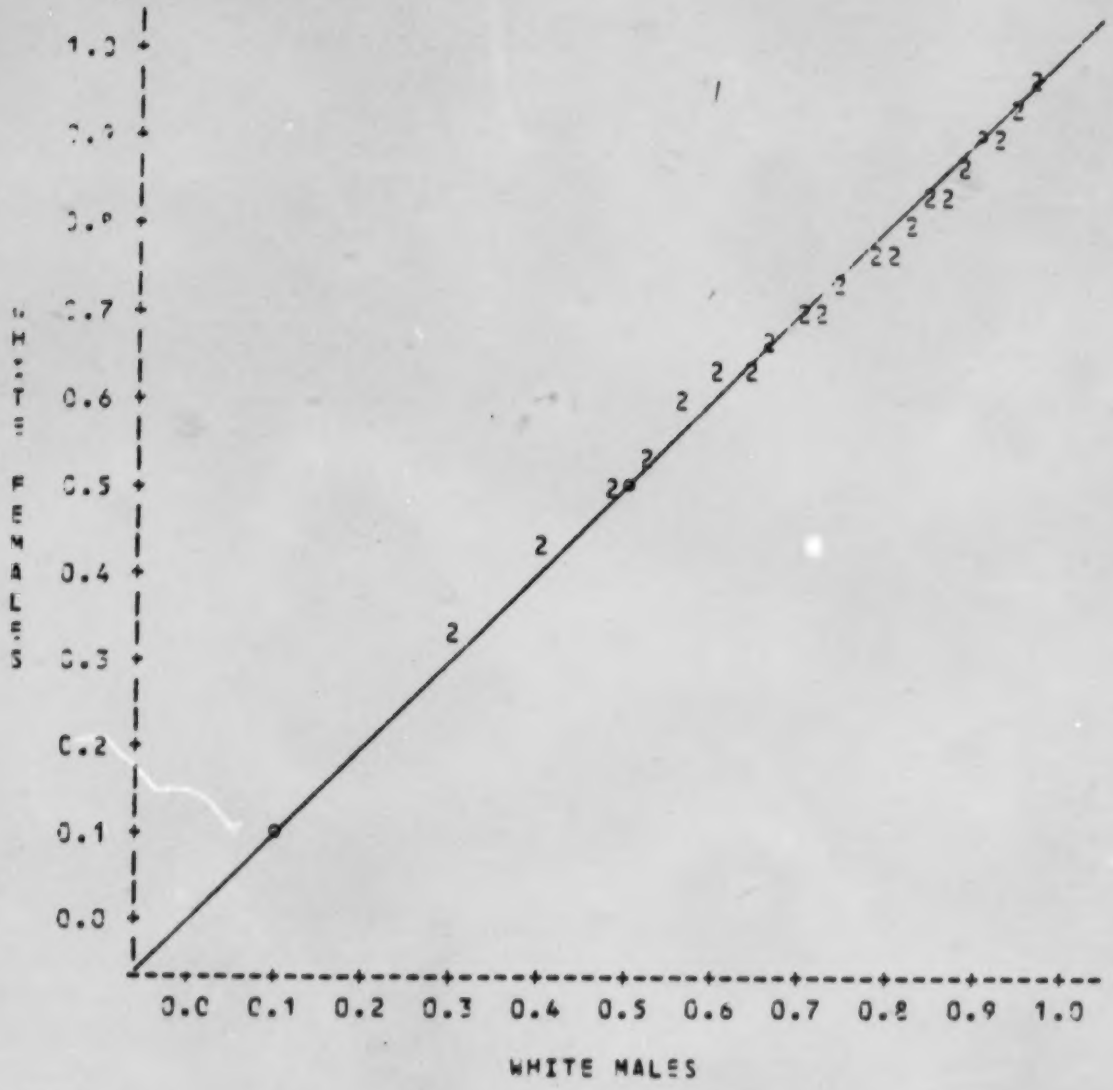


Exhibit 3-15. Q-Q plot, proportion of exercises answered correctly by black females vs. proportion answered correctly by white females, age 13, Sample 1.

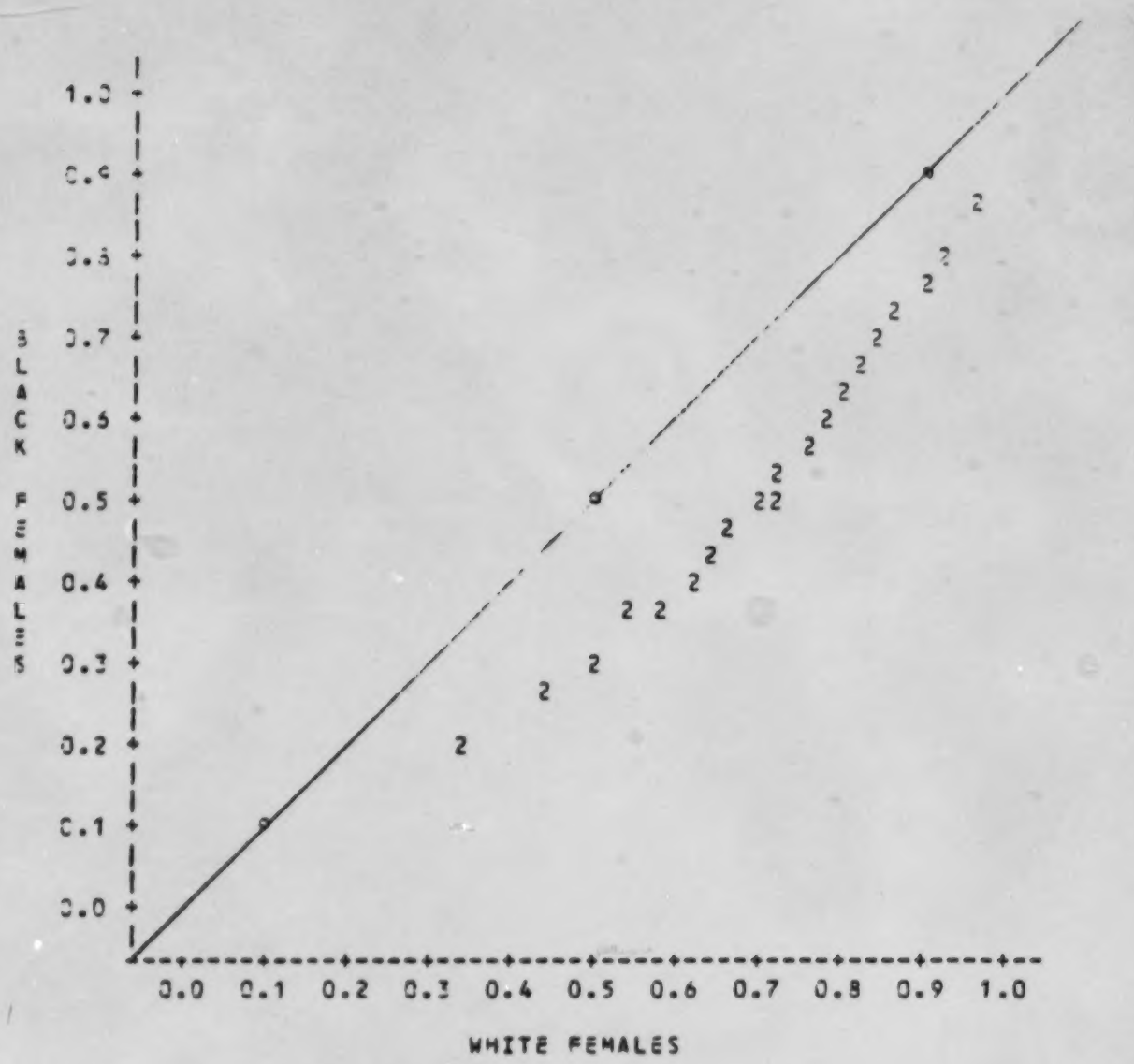


Exhibit 3-16. Q-Q plot, proportion of exercises answered correctly by black males vs. proportion answered correctly white males, age 13, Sample 1.

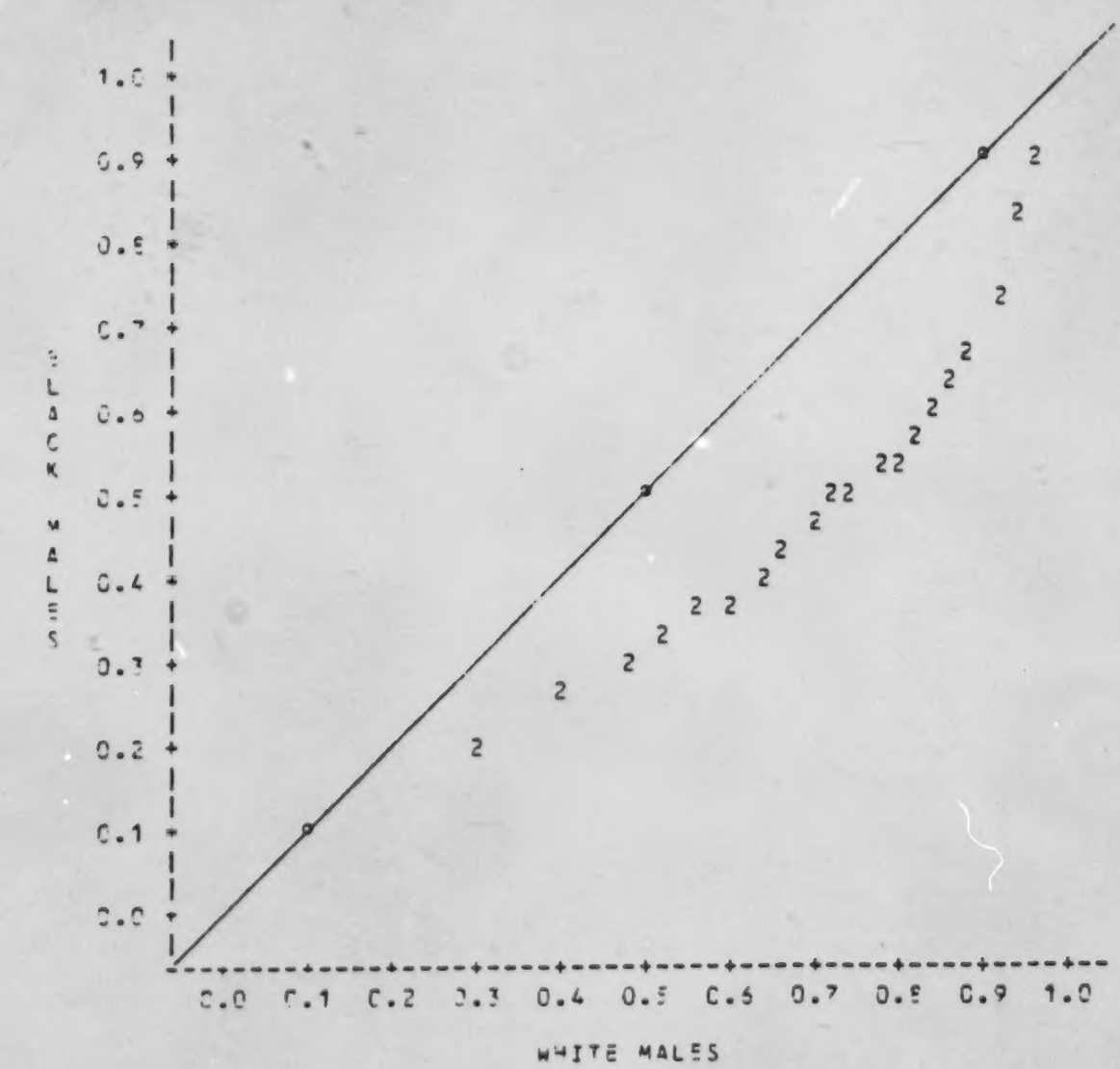


Exhibit 3-15, the Q-Q plot of black vs. white females at age 13, reflects large differences between the two distributions. The median score for black females, 50.9 percent correct, is far below that for white females, 71.1 percent correct.

Only about 16 percent of the white females display scores below the median for black females. At the high end of the distribution, 30 percent of the white females but only 5 percent of the black females achieve scores of 80 percent correct or above.

Exhibit 3-16 compares black males with white males at age 13. The medians are 48.5 and 72.1 percent correct for blacks and whites, respectively. About 16 percent of the white males fell below the median for blacks; about 13 percent of the black males score above the white median of 72.1. Nearly 40 percent of the whites but only 5 percent of the blacks display scores as high as 80 percent correct.

Age 17. Exhibit 3-17 shows the Q-Q plot of mathematics achievement scores for black females vs. black males at age 17, Sample 1. It is evident that the median score is lower for black females than for black males (34.9 vs. 38.1 percent correct) and that the spread is less for black females (the slope of the best-fitting line is less than 1). Both distributions are skewed upwards.

Exhibit 3-18 is the plot for white females vs. white males. The most prominent difference in the distributions is one of central tendency. The median score for white females is 66.7 and that for white males is 72.8 percent correct.

The Q-Q plots for black females vs. white females (Exhibit 3-19) and for black males vs. white males (Exhibit 3-20) are quite similar in form, both showing large differences between the two cumulative distributions. Inspection of Q-Q plots at both ages has confirmed the conclusions about differences in location and scale that were based upon comparisons of group means and variances, and also has provided a comparison of other features of the distributions.

Effects of Adjusting the Scores. The analyses reported until now were based upon achievement scores that depend upon simply the percent of exercises answered correctly. Comparisons of subgroup means and variances also were performed on the arcsine of the proportion (p) of exercises answered correctly. Findings from the two sets of analyses are essentially identical. Since analyses of arcsine p yield the same findings as analyses of the percent correct, results of the latter were presented here, having an advantage of simplicity and straightforward interpretation.

An alternative scoring procedure traditionally has been used in national testing programs, where a "formula" score, X, is determined as

$$X = R - W/(k-1); \qquad (3.3)$$

R is the number of right answers, W is the number of wrong answers, and k is

Exhibit 3-17. Q-Q plot, proportion of exercises answered correctly by black females vs. proportion answered correctly by black males age 17, Sample 1.

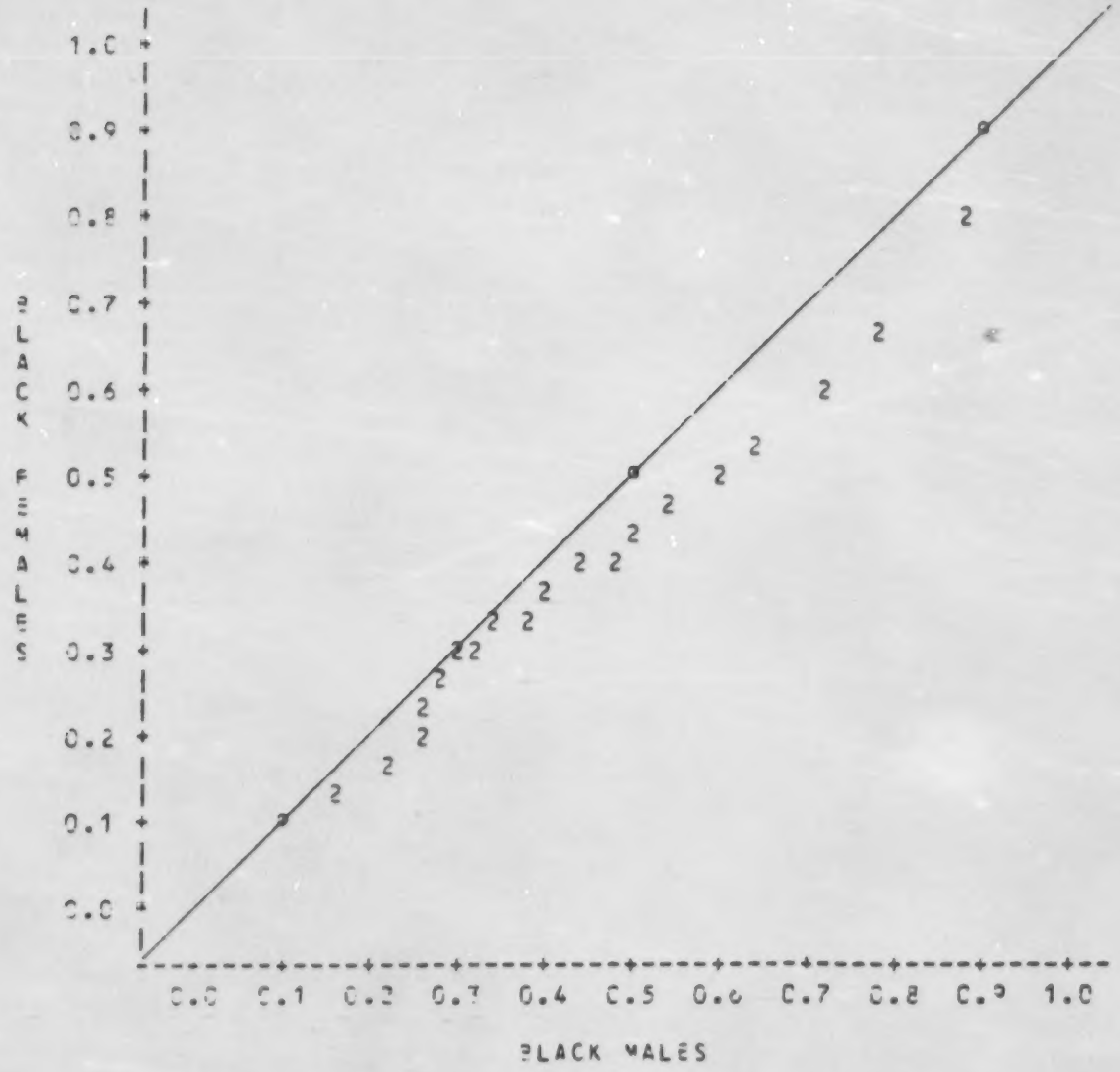


Exhibit 3-18. Q-Q plot, proportion of exercises answered correctly by white females vs. proportion answered correctly by white males, age 17, Sample 1.

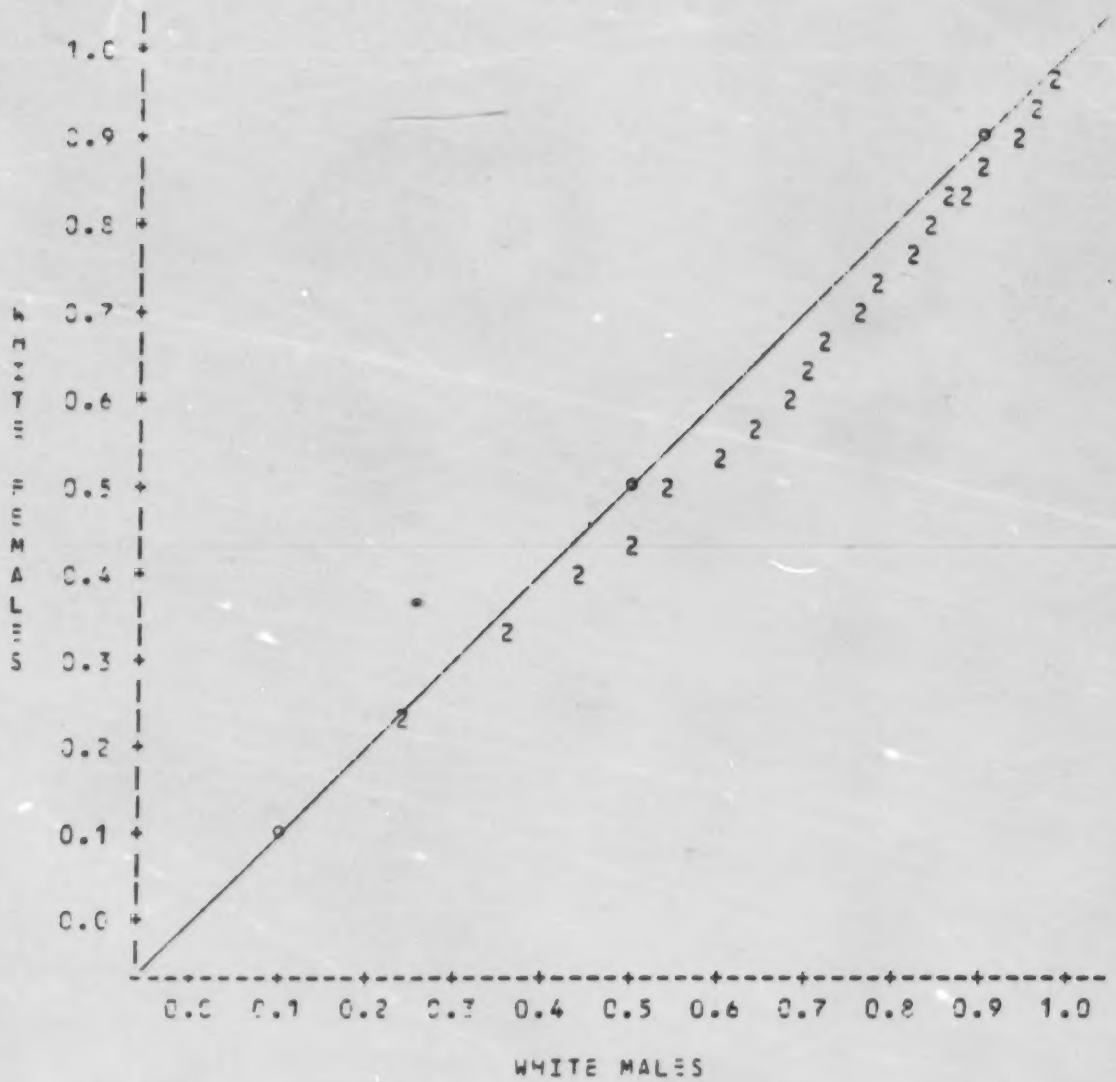


Exhibit 3-19. Q-Q plot, proportion of exercises answered correctly by black females vs. proportion answered correctly by white females, age 17, Sample 1.

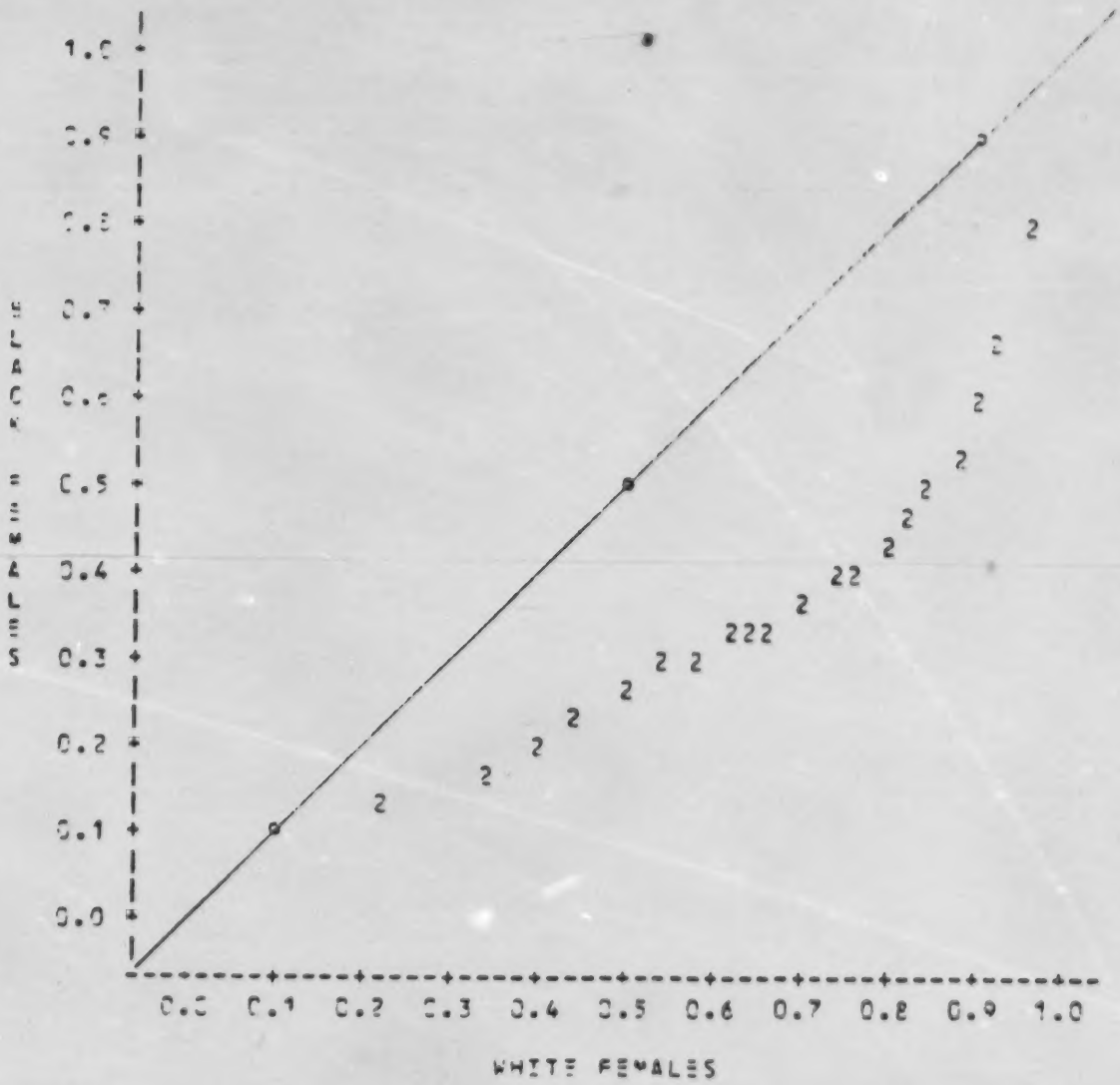
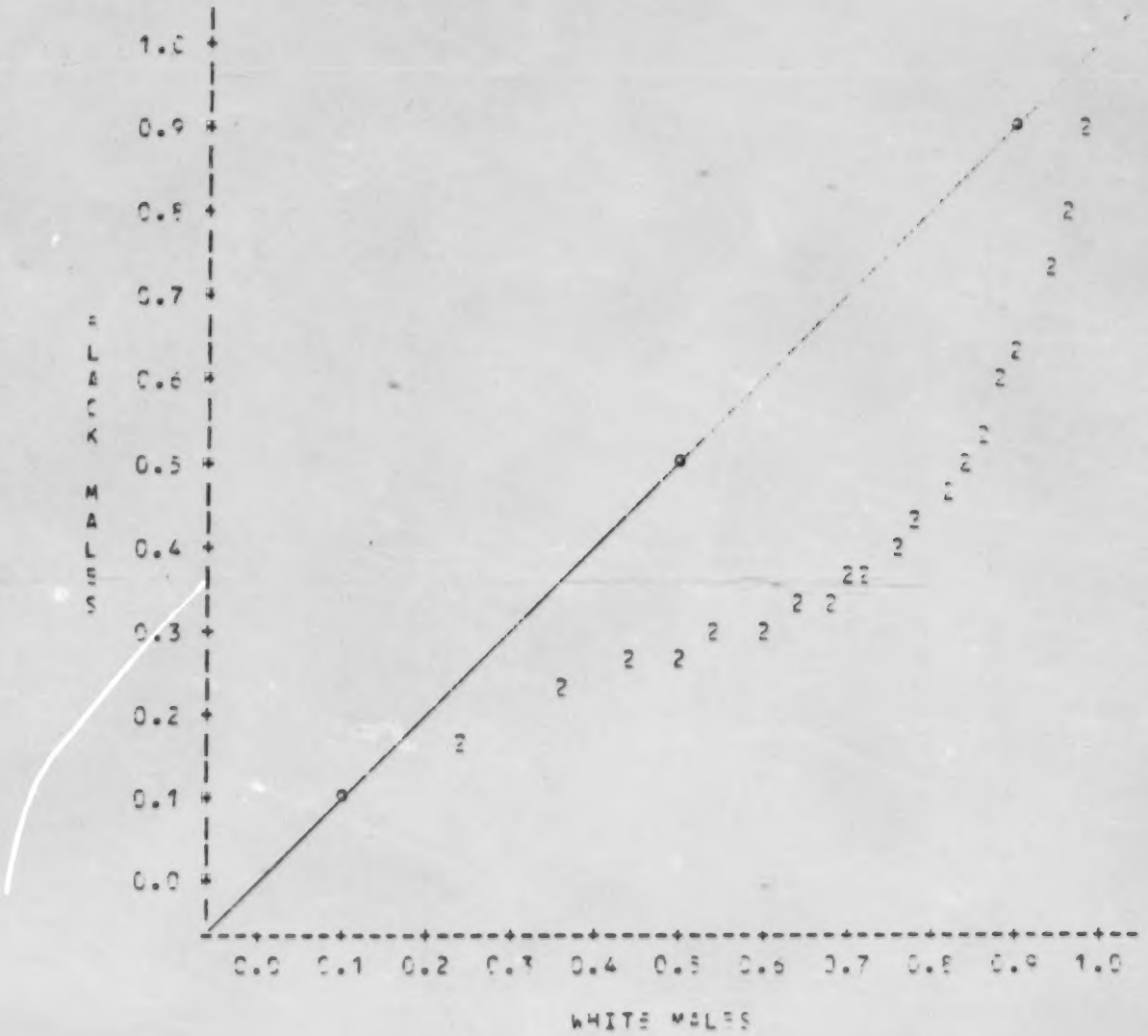


Exhibit 3-20. Q-Q plot, proportion of exercises answered correctly by black males vs. proportion answered correctly by white males, age 17, Sample 1.



the number of substantive multiple-choice response alternatives. ("I don't know" is not counted as one of the k alternatives.) The intent of the formula is to yield an expected score of zero for any individual who marks answers to exercises at random.

When tests are scored by right answers only, it is appropriate that examinees be instructed to guess answers rather than to omit answers to exercises, since fortunate guesses will improve their scores while omissions cannot. When tests are scored to yield X by the formula above, it is appropriate that examinees be instructed that pure guessing is risky, and could lower their scores, but that guessing based upon partial knowledge will likely raise their scores.

Since NAEP instructions discourage respondents from guessing, it is not inappropriate to compute formula scores for NAEP data. Perhaps scoring by formula would change the race-sex mean performance differences reported above, based upon rights-only scoring.

Some pertinent findings concerning the effect on race differences of rights-only vs. formula scoring of items on the verbal portion of the Scholastic Aptitude Test were recently reported by Angoff and Schrader (1981). The verbal portion of the SAT consists of 70 items, in two timed parts, and includes antonyms, analogies, sentence completion, and reading comprehension. Angoff and Schrader administered two forms of the SAT-V to high school students from 69 schools in 19 states. Half the respondents to each form were given rights-only scoring instructions and half were given formula scoring instructions. Sample sizes for the two races in these testing conditions, further broken down by four ability classes, are given in Exhibit 3-21 (from Angoff and Schrader, 1981, Tables 7, 10, 11, and 12).

Although group means were not directly reported, they can be reconstructed from information provided on total test length, average number wrong and average number omitted by group. In order that rights-only and formula scores be on a comparable scale, the mean scores have been standardized using the four form x scoring condition means and standard deviations given in Angoff and Schrader (1981, Table 2, p. 7). Finally, because the two highest ability classes contained so few blacks, those ability classes have been collapsed for our analyses. The results are tabled in Exhibit 3-22 and are graphed in Exhibit 3-23.

The two scoring procedures give virtually identical results, except for a slight tendency for formula scores to enhance the apparent superiority of high-ability students within both black and white groups. Since a smaller proportion of blacks are in the high ability class (approximately 25 percent, as compared to about 73 percent for whites), formula scoring would be expected to accentuate the average race differences.

We turn now to the NAEP mathematics achievement data, to determine the effect, if any, that formula scoring has on the race and sex mean differences based on rights-only scoring, as presented earlier in this chapter. Exhibits 3-24 and 3-25 contrast summary data for formula scores, as defined by equation (3.3), with rights-only scores. For the purpose of comparing the means

Exhibit 3-21. Sample sizes by scoring condition, SAT-V form, and ability class for Angoff and Schrader study.

Scoring condition	Form	Ability Class*	Race	
			Black	White
Rights	A	25 and above	18	316
		20-24	46	223
		15-19	61	120
		14 and below	77	35
	B	25 and above	19	278
		20-24	46	217
		15-19	59	146
		14 and below	91	67
Formula	A	21 and above	12	277
		15-20	45	262
		9-14	70	128
		8 and below	64	47
	B	21 and above	14	245
		15-20	22	236
		9-14	56	151
		8 and below	100	78

*In raw-score units for rights-only scores; in raw scores corrected by equation (3.3) for formula scores.

of rights only with the means of formula scores for the four race-sex groups, it is necessary that they be converted to a common scale. Each set of four means thus was standardized to yield an overall mean of 50 and a pooled within-group standard deviation of 10. The resulting standardized means and standard errors of those means are given in Exhibit 3-24 for Sample 1 and in Exhibit 3-25 for Sample 2.

Within each age and sample, the choice of scoring by rights only or formula does not systematically effect race-sex means and standard errors of those means. Mean differences between blacks and whites on NAEP mathematics achievement exercises appear to be invariant over changes from scoring by number of right answers to scoring by formula.

Exhibit 3-22. Mean standardized SAT-V scores by method of scoring, race and ability class.

Scoring Condition	Ability Class	Form A		Form B		Both Forms	
		Black	White	Black	White	Black	White
Rights	high	49.1	55.2	51.0	54.9	49.9	55.1
	medium	41.9	45.2	43.2	47.3	42.5	46.4
	low	36.7	40.8	37.3	40.2	37.0	40.4
Formula	high	51.0	56.0	53.1	56.5	51.8	56.2
	medium	41.6	45.4	43.0	46.9	42.2	46.2
	low	37.6	40.1	37.3	41.2	37.4	40.8

Exhibit 3-23. Comparison of formula scores to rights-only scores, SAT-V, by race and ability group.

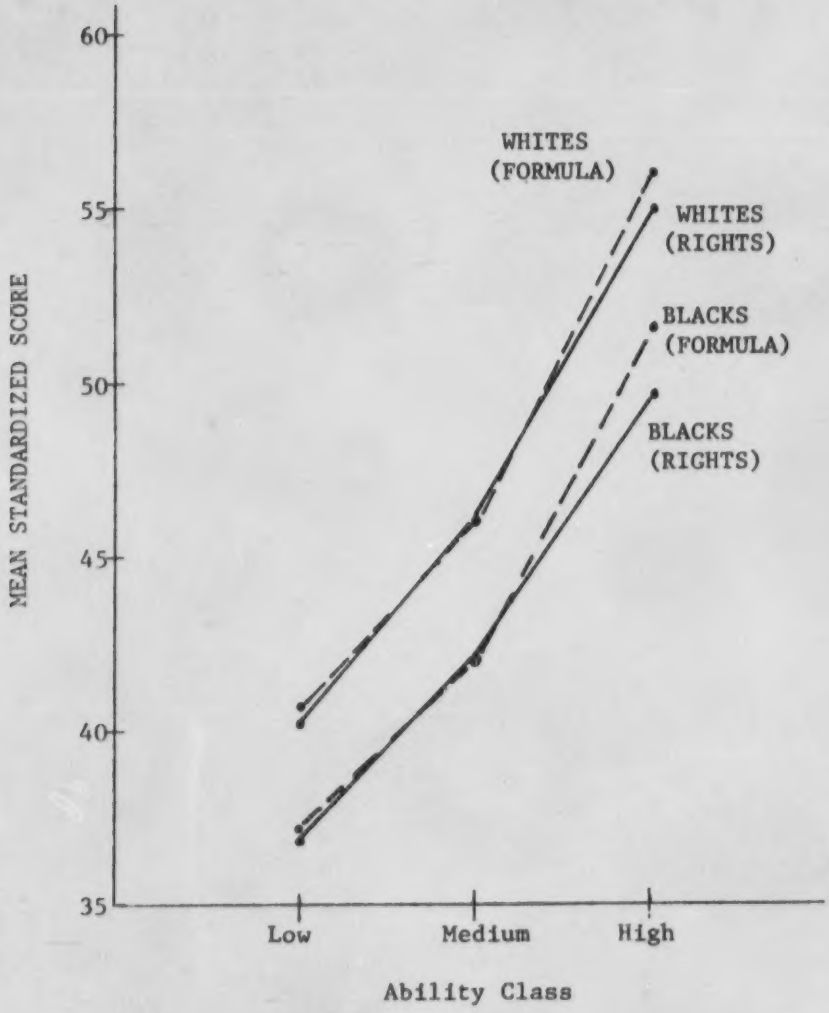


Exhibit 3-24. Standardized means and standard errors for two scoring methods ages 13 and 17, Sample 1.

			Rights			Formula		
			Sex			Sex		
Age	Statistic	Race	F	M	Both	F	M	Both
13	Mean	B	41	40	40	42	40	41
		W	52	52	52	52	52	52
		Both	50	50	50	50	50	50
	Standard	B	1.1	1.4		.9	1.3	
	Error	W	.4	.5		.4	.4	
17	Mean	B	37	40	38	36	39	38
		W	50	53	52	51	53	52
		Both	49	51	50	49	51	50
	Standard	B	.8	1.1		.8	.9	
	Error	W	.4	.3		.4	.3	

Exhibit 3-25. Standardized means and standard errors for two scoring methods, ages 13 and 17, Sample 2.

			Rights			Formula		
			Sex			Sex		
Age	Statistic	Race	F	M	Both	F	M	Both
13	Mean	B	41	40	41	41	40	40
		W	51	52	52	51	52	52
		Both	50	50	50	50	50	50
	Standard Error	B	1.4	1.0		1.4	1.0	
		W	.5	.4		.5	.4	
16	Mean	B	37	30	38	37	39	38
		W	50	53	52	50	53	52
		Both	49	51	50	49	51	50
	Standard Error	B	1.0	1.4		1.1	1.4	
		W	.3	.2		.3	.2	

Chapter 4

Relations between Achievement and Selected Background Characteristics

In Chapter 3, mathematics achievement differences were found to be associated at age 13 and 17 with race (black or white) and, at age 17, to a lesser extent, with sex. In this chapter, we inquire about effects of other community, school and home factors: region, level of parental occupation in the school, type of community, reading materials in the home, level of parental education, and school grade in which the student is enrolled. At age 17, we also consider effects of mathematics courses taken in high school and of grade point average. The effects of these background variables will be assessed one at a time, in each case after removal of race effects. Note that, since many of these factors are correlated, the effects noted in this chapter are not independent, one from the other. In Chapter 5, the effects of background variables will be studied simultaneously, by methods of multiple regression, taking account of the correlations among the factors.

Age 13

Race and Sex. The effects associated with race and sex were presented in Chapter 3, specifically by finding parameters of a simple additive model (Equation 3.1). At age 13, based upon evidence both from Sample 1 and Sample 2, race was found to be related to achievement, and no sex effect was found. White students were found to perform at an average level 2 percentage points above the national average, while the performance of black students was found to be 15 percentage points below the national average. Codifying this information in the form of (3.1), r_i has a value of 2 for whites and a value of -15 for blacks.

In addition to race and sex, three other background variables are assessed for each individual student: grade, parental education, and printed materials in the home (FAMSUM). Information about parental education and home reading materials is provided by the student. Three other variables are associated with schools (rather than with individuals within schools): community type, parental occupation (OCC), and region.

Grade. At age 13, students were classified by grade, either below the modal grade (grade 8) or at or above that grade. For our samples, 35 percent of the black 13-year-olds and 26 percent of the whites are found to be below modal grade. Exhibit 4-1 shows the performance of blacks and whites, by this classification, for Samples 1 and 2, and also shows the steps taken to estimate effects of grade. Students of either race who are below modal grade perform about 10 percentage points below the national average for that race, while those at or above modal grade perform about 4 percentage points above the national average for their race. Letting g represent an effect associated with grade, we may substitute g for s in equation (3.1) to arrive at

$$D = r + g. \qquad (4.1)$$

The value of g is -10 for below modal grade and 4 for at or above modal grade.

Parental Education. For present purposes, parental education is defined as the student's report of the highest educational level achieved by either parent, and is categorized as high-school graduation or less (HS) vs. some education beyond high school (HS+). Two other categories have been added, to accommodate students who responded "I don't know" and students who gave no response. We estimate, based on sampling weights applied to both, that black and white 13-year-olds are distributed as follows over levels of parental education:

	IDK	HS	NR	HS+	
B	18.5	46.2	7.2	28.1	(100.0)
W	10.6	43.3	1.2	44.9	(100.0)

Exhibit 4-2 shows mean performance for Samples 1 and 2, by race and parental education, and provides the basis for estimating e, the effect of parental education, in the equation

$$D = r + e. \qquad (4.2)$$

Effects are similar for blacks and whites. The estimated effects range from -8 for the "I don't know" response, -2 for high school graduation or less, 0 for no response, to 6 for education beyond high school.

Printed Materials in the Home. Each child was asked the following questions concerning printed materials in the home:

> Are there more than 25 books in your home?
> Is there an encyclopedia in your home?
> Does your family get any magazines regularly?
> Does your family get a newspaper regularly?

Answers to each question were coded 0 if "no," 1 if "yes." An index of printed materials in the home is the sum of 1's for these four questions, here called FAMSUM. We estimate that black and white 13-year-olds are distributed as follows over levels of FAMSUM:

	FAMSUM					
Race	0	1	2	3	4	
B	1.8	8.1	19.2	35.2	35.7	(100.0)
W	.9	3.2	9.5	25.5	60.9	(100.0)

Exhibit 4-3 shows mean mathematics scores for black and white children, by level of FAMSUM, and develops the estimates of the effect associated with each level. Results suggest that the effects are stronger for whites than for blacks at low levels of FAMSUM (0, 1, and 2). Note that 29 percent of blacks but only 13.6 percent of whites fall into the lowest three categories. The values of f in the equation

$$D = r + f \qquad (4.3)$$

are seen to range for blacks from a value of -11 percent for FAMSUM = 0 to 6 percent for FAMSUM = 4, and for whites from -17 percent for FAMSUM = 0 to 4 for FAMSUM = 4.

Exhibit 4-1. Effects of grade, age 13, Samples 1 and 2.

a. Mean mathematics score (percent correct):

Sample 1

Race	Grade: Below modal	Grade: Modal or above
B	41.9	57.8
W	59.2	74.4

Sample 2

Race	Grade: Below modal	Grade: Modal or above
B	48.1	61.9
W	64.0	76.4

b. National mean score:

Sample 1	Sample 2
68.0	71.0

c. a - b:

Race	Sample 1: Below modal	Sample 1: Modal or above	Race	Sample 2: Below modal	Sample 2: Modal or above
B	-26.1	-10.2	B	-22.9	-9.1
W	- 8.8	6.4	W	- 7.0	5.4

d. Weighted average of Samples 1 and 2:

Race	Grade: Below modal	Grade: Modal or above
B	-24.5	-9.6
W	- 7.9	5.9

e. a - b - r (where r for blacks is -15 and for whites is 2):

B	-10	5
W	-10	4

f. Effect of grade, combined over race:

Below modal	Modal or above
-10	4

Exhibit 4-2. Effects of parental education, age 13, Samples 1 and 2.

Sample 1

a. Mean mathematics score (percent correct):

Race	Parental education IDK	HS	NR	HS+
B	44.5	51.7	56.1	57.8
W	62.0	66.9	74.5	75.9

b. National mean score:

68.0

c. a - b:

B	-23.5	-16.3	-11.9	-10.2
W	- 6.0	- 1.1	6.5	7.9

Sample 2

Race	Parental education IDK	HS	NR	HS+
B	51.7	55.8	56.1	62.2
W	64.1	70.1	68.9	78.6

71.0

B	-19.3	-15.2	-14.9	-8.8
W	- 6.9	- 0.9	- 2.1	-7.6

d. Weighted average of Samples 1 and 2:

Race	Parental education IDK	HS	NR	HS+
B	-21.6	-15.8	-13.6	-9.5
W	- 6.4	- 1.0	2.0	7.8

e. a - b - r (where r for blacks is -15 and for whites is 2):

B	-7	-1	1	5
W	-8	-3	0	6

f. Effect of parental education, combined over race:

IDK	HS	NR	HS+
-8	-2	0	6

Exhibit 4-3. Effects of FAMSUM, age 13, Samples 1 and 2.

Sample 1

a. Mean mathematics score (percent correct):

Race	FAMSUM 0	1	2	3	4
B	38.8	41.0	46.9	50.4	59.9
W	43.9	54.4	59.6	66.9	74.5

b. National mean score:

68.0

c. a - b:

Race	FAMSUM 0	1	2	3	4
B	-29.2	-27.0	-21.1	-17.6	-8.1
W	-24.1	-13.6	- 8.4	- 1.1	6.5

Sample 2

Race	FAMSUM 0	1	2	3	4
B	47.1	52.0	53.0	56.3	61.4
W	58.7	62.3	64.1	70.2	77.1

71.0

Race	FAMSUM 0	1	2	3	4
B	-23.9	-19.0	-18.0	-14.7	-9.6
W	-12.3	- 8.7	- 6.9	- 0.8	6.1

d. Weighted average of Samples 1 and 2:

Race	FAMSUM 0	1	2	3	4
B	-25.7	-23.2	-19.6	-16.2	-8.9
W	-15.1	-10.9	- 7.6	- 1.0	6.3

e. a - b - r (where r for blacks is -15 and for whites is 2):

B	-11	- 9	- 5	- 1	6
W	-17	-13	-10	- 3	4

Community Type. For present purposes, students were classified by type of community into four distinct, exhaustive classes: extreme rural, low metro, high metro, and the rest of the nation. We estimate that black and white 13-year-olds are distributed as follows over community types:

	ER	LM	Rest	HM	
B	4.5	23.2	67.2	5.1	(100.0)
W	9.3	3.2	77.6	9.9	(100.0)

Exhibit 4-4 shows the performance data, based upon this classification (for blacks and for whites) and also shows the basis for estimating the effects t for community type in the equation

$$D = r + t. \qquad (4.4)$$

It is seen that, for blacks, t takes on values -7 for extreme rural, -1 for low metro, 13 for high metro, and 0 for the rest. For whites, t is -2 extreme rural, 8 for high metro, and 0 both for low metro and the rest. Notably, for blacks, effects are more extreme than for whites for extreme rural (negative effects) and for high metro (positive effects).

Parental Occupation. An index of parental occupation was defined for each school, based upon responses to a principal's questionnaire, as the difference between the principal's estimate of the percentage of professionally employed parents and the percentage of parents who receive welfare support. An index of -100 would result were all parents said to be on welfare; an index of 100 would result were all parents professionally employed. Four levels of OCC are established: 1 if the percentage difference is -99 to -11; 2 if the difference is -1 to -10; 3 if the difference is 0 to 10; and 4 if the difference is 11 to 99. We estimate that black and white 13-year-olds are distributed as follows over levels of OCC:

	OCC				
Race	1	2	3	4	
B	35.2	24.2	20.8	19.8	(100.0)
W	13.2	21.6	31.0	34.2	(100.0)

Results of analyzing performance by levels of OCC appear in Exhibit 4-5. The values of o in the equation

$$D = r + o \qquad (4.5)$$

range from -3 for schools in which the principals estimate at least 10 percent more parents on welfare than professionally employed (OCC = 1), to 5 for schools where the percentage of professionally employed parents exceeds those on welfare by more than 10 percent (OCC = 4).

Region. For present purposes, region was defined as Southeast vs. Northeast, Central, and West. (To separate students into the four regions would result in too few black students in some cells to provide stable results.) We estimate that 43 percent of the black 13-year-olds and 20 percent of the whites are in the Southeast. Exhibit 4-6 shows results by race

Exhibit 4-4. Effects of community type, age 13, Samples 1 and 2.

Sample 1

a. Mean mathematics score (percent correct):

Race	Community type ER	LM	Rest	HM
B	41.0	52.1	51.6	71.0
W	68.3	70.4	69.7	78.7

b. National mean score: 68.0

c. a - b:

B	-27.0	-15.9	-16.4	3.0
W	0.3	2.4	1.7	10.7

Sample 2

Race	Community type ER	LM	Rest	HM
B	51.9	54.6	57.5	65.6
W	70.3	72.3	72.7	80.6

National mean score: 71.0

B	-19.1	-16.4	-13.5	-5.4
W	-0.7	1.3	1.7	9.6

d. Weighted average of Samples 1 and 2:

Race	Community type ER	LM	Rest	HM
B	-22.4	-16.2	-15.0	-1.7
W	-0.2	1.8	1.7	10.1

e. Effect of community type: a - b - r (where r for blacks is -15 and for whites is 2):

B	- 7	- 1	0	13
W	- 2	0	0	8

Exhibit 4-5. Effects of OCC, age 13, Samples 1 and 2.

a. Mean mathematics score (percent correct):

Sample 1

Race	OCC 1	2	3	4
B	48.1	51.2	52.4	59.3
W	67.5	68.4	69.3	74.0

Sample 2

Race	OCC 1	2	3	4
B	53.7	56.6	56.5	64.6
W	69.3	70.7	72.6	77.1

b. National mean score:

Sample 1	Sample 2
68.0	71.0

c. a - b:

	Sample 1				Sample 2			
B	-19.9	-16.8	-15.6	-8.7	-17.3	-14.4	-14.5	-6.4
W	- 0.5	0.4	1.3	6.0	- 1.7	- 0.3	1.6	6.1

d. Weighted average of Samples 1 and 2:

Race	OCC 1	2	3	4
B	-18.6	-15.5	-15.1	-7.7
W	- 1.1	0.0	1.4	6.1

e. a - b - r (where r for blacks is -15 and for whites is 2):

B	-4	0	0	7
W	-3	-2	-1	4

f. Effect of OCC, combined over race:

1	2	3	4
-3	-1	-1	5

Exhibit 4-6. Effects of region, age 13, Samples 1 and 2.

	Sample 1		Sample 2		
a. Mean mathmetics score (percent correct):					
	Region			Region	
Race	S	NCW	Race	S	NCW
B	47.6	55.6	B	55.9	57.8
W	66.0	71.7	W	69.4	74.2
b. National mean score:	68.0			71.0	
c. a - b:					
B	-20.4	-12.4	B	-15.1	-13.2
W	- 2.0	3.7	B	- 1.6	3.2

d. Weighted average of Samples 1 and 2:

	Region	
Race	S	NCW
B	-17.8	-12.8
W	-1.8	3.4

e. a - b - r (where r for blacks is -15 and for whites is 2):

B	-3	2
W	-4	1

f. Effect of region, combined over race:

S	NCW
-3	2

and region, and the basis for generating estimates of p for region (place) in

$$D = r + p \qquad (4.6)$$

For students in the Southeast, p is estimated to be -3, and for students elsewhere, p = 2.

Summary, Background Variables within Race, Age 13. The effects at age 13 are summarized in schematic form in Exhibit 4-7. For each background variable except community type, effects are seen to be of the same magnitude for black students and white students. Community type appears to be a more influential variable for blacks than for whites, with a difference of 22 percent between extreme rural and high metro for blacks and a difference of 14 percent for whites. Ordered by an index of apparent influence, the spread of effects from highest to lowest category, variables at age 13 are as follows:

Variable	Influence
FAMSUM (for whites)	21 percent
Community type (for blacks)	20 percent
FAMSUM (for blacks)	17 percent
Grade	14 percent
Parental education	14 percent
Community type (for whites)	10 percent
OCC	8 percent
Region	5 percent

At age 13, in addition to race (with influence of 17 percent), printed materials in the home (FAMSUM), community type, grade, and parental education appear to be prominently related to the level of achievement in mathematics.

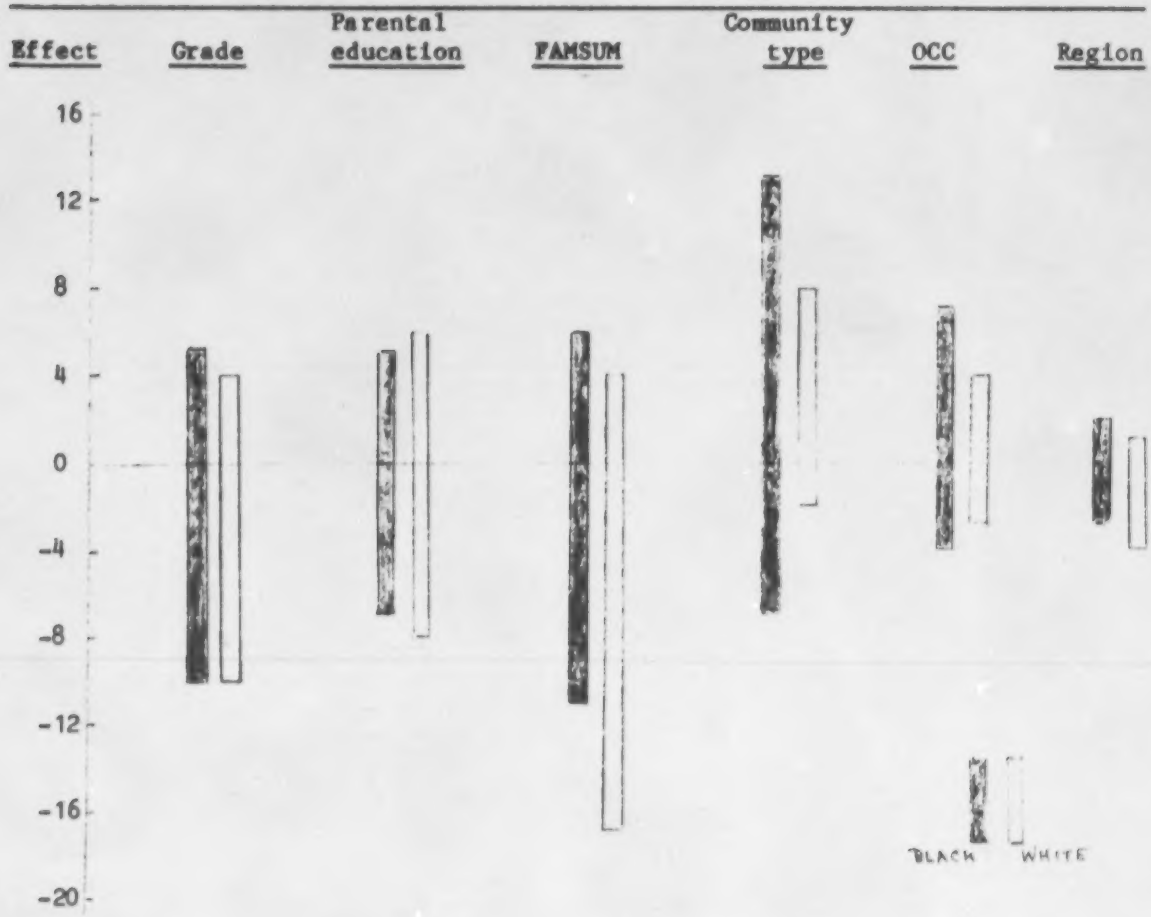
Age 17

Race and Sex. At age 17, race effects were found in Chapter 3 to be -22 percent for blacks and 3 percent for whites, while sex effects were -2 percent for females and 2 percent for males.

We proceed to present effects of background variables in the same order as for age 13: the three individual variables, grade, parental education, and FAMSUM, followed by the three school variables, community type, OCC, and region.

Grade. At age 17, each respondent was assigned to one of four categories for grade: dropout, below modal grade, at modal grade, or above modal grade (including high school graduates). We estimate that 17-year-old black females and males and white females and males are distributed as follows over levels of grade:

Exhibit 4-7. Schematic summary of effects within race, age 13.



Female

Race	Dropout	Below Modal	Modal	Above Modal	
B	7.5	19.9	61.0	11.6	(100.0)
W	5.5	7.8	74.7	12.0	(100.0)

Male

B	5.4	31.8	53.3	9.5	(100.0)
W	4.5	15.4	71.6	8.5	(100.0)

Note that, at age 17, there are different distributions over grade as a function of both race and sex. However, when effects of grade were assessed by sex within race, it was found that effects of grade level were essentially the same for females and for males, within race. Consequently, the results presented in Exhibit 4-8 are those determined after combining the sexes within race. After combining over sexes, we estimate that black and white 17-year-olds are distributed as follows over levels of grade:

		Dropout	Below Modal	Modal	Above Modal	
Race	B	6.6	25.3	57.4	10.7	(100.0)
	W	5.0	11.5	73.2	10.3	(100.0)

Exhibit 4-8 shows the average performance of 17-year-olds by race (in mean percent correct answers) for each category, Sample 1 and Sample 2, and shows the steps taken to estimate effects associated with each category. I.e., for each race we estimate four values of g in the equation

$$D = r + g. \qquad (4.7)$$

For blacks, these estimates are, for dropouts, -17; for below modal grade, -7; for modal grade, 3; and for above modal grade, 8. For whites, we find corresponding effects of -26 , -14, 3, and 7. Note that, at age 17, being behind grade seems relatively more influential for whites than for blacks; the negative effects associated with dropouts and those below modal grade are stronger for whites than for blacks.

Parental Education. Parental education also is defined at age 17 as it was at age 13. We estimate that black and white 17-year-olds are distributed as follows over levels of parental education:

	IDK	HS	NR	HS+	
B	12.8	57.0	3.3	26.9	(100.0)
W	4.5	45.9	0.9	48.7	(100.0)

Results are shown in Exhibit 4-9. Effects range from -8 for an "I don't know" response, to -4 for high school or less, to 0 for no response, to 6 for post-high-school education for one or the other parent. These effects are quite similar to those found at age 13 for parental education.

Exhibit 4-8. Effects of grade, age 17, Samples 1 and 2.

Sample 1

a. Mean mathematics score (percent correct):

Race	Grade: Dropout	Below modal	Modal	Above modal
B	25.5	33.3	45.4	48.6
W	41.1	53.8	71.5	75.4

b. National mean score:

65.2

c. a - b:

B	-39.7	-31.9	-19.8	-16.6
W	-24.1	-11.4	6.3	10.2

Sample 2

Race	Grade: Dropout	Below modal	Modal	Above modal
B	29.3	39.7	48.4	55.6
W	44.2	56.5	71.7	75.9

66.3

B	-37.0	-26.6	-17.9	-10.7
W	-22.1	-9.8	5.4	9.6

d. Weighted average of Samples 1 and 2:

	Dropout	Below modal	Modal	Above modal
B	-38.8	-29.4	-18.8	-13.6
W	-23.1	-10.6	5.8	9.9

e. a - b - r (where r for blacks is -22 and for whites is 3):

B	-17	-7	3	8
W	-26	-14	3	7

Printed Materials in the Home. As at age 13, we may assess effects of FAMSUM, an index of home environment, defined at age 17 just as it was for age 13. We estimate that black and white 17-year-olds are distributed as follows over levels for age 13.

	FAMSUM					
Race	0	1	2	3	4	
B	1.8	8.0	16.7	30.0	43.5	(100.0)
W	.5	2.0	7.3	21.0	69.2	(100.0)

Results of the analysis of effects associated with FAMSUM appear in Exhibit 4-10. As was found at age 13, effects appear stronger for whites than for blacks. Effects for blacks range from -13 percent (FAMSUM = 0) to 5 percent (FAMSUM = 4); corresponding effects for whites are -30 percent and 3 percent.

Community Type. The different community types in which the schools are located at age 17 are identical to those defined at age 13. However, high schools are larger than and organized differently from elementary and junior high schools, and present a different distribution over community type. Since the distributions for both sexes (within race) are highly similar, we may ignore sex and consider the percentage distribution over community type separately. We estimate that black and white 17-year-olds are distributed as follows:

	ER	LM	Rest	HM	
B	1.6	39.4	56.9	2.1	(100.0)
W	8.2	5.0	76.4	10.4	(100.0)

Exhibit 4-11 displays the summary data, and the way in which effects were estimated. As at age 13, community type is more influential for blacks than for whites, with effects ranging from -5 for extreme rural to 20 for high metro. Effects for whites range from -5 for low metro to 4 for high metro. Note that the largest negative effect is associated with rural community type for blacks at age 17 but with low metro (inner city environment) for whites.

Parental Occupation. At age 17, the variable OCC is defined precisely as at age 13, with four levels representing different degrees of discrepancy between numbers of professionally employed parents and numbers of parents with welfare support in a school. We estimate that 17-year-olds are distributed as follows over levels of OCC:

	OCC				
Race	1	2	3	4	
B	42.1	19.8	19.4	18.7	(100.0)
W	3.2	12.3	36.0	48.5	(100.0)

This distribution is remarkably different from that found at age 13. For the 17-year-olds, more blacks and fewer whites are attending schools that are characterized by principals as having many more welfare families than professional families. A substantially larger number of whites, compared with age 13, are attending schools with more professional than welfare families.

Exhibit 4-9. Effects of parental education, age 17, Samples 1 and 2.

Sample 1

a. Mean mathematics score (percent correct):

Race	Parental education IDK	HS	NR	HS+
B	37.4	39.5	33.5	47.2
W	55.8	62.8	72.3	74.6

b. National mean score:

65.2

c. a - b:

B	-27.8	-25.7	-31.7	-18.0
W	- 9.4	- 2.4	7.1	9.4

Sample 2

Race	Parental education IDK	HS	NR	HS+
B	41.0	43.8	43.5	53.8
W	60.5	64.8	69.5	73.8

66.3

B	-25.3	-22.5	-22.8	-12.5
W	- 5.8	- 1.5	3.2	7.4

d. Weighted average of Samples 1 and 2:

Race	Parental education IDK	HS	NR	HS+
B	-26.3	-24.2	-28.4	-15.5
W	- 7.8	- 2.0	4.6	8.4

e. a - b - r (where r for blacks is -22 and for whites is 3):

B	-4	-2	-6	6
W	-11	-5	2	5

f. Effect of parental education, combined over race:

IDK	HS	NR	HS+
-8	-4	0	6

Exhibit 4-10. Effects of FAMSUM, age 17, Samples 1 and 2.

Sample 1

a. Mean mathematics score (percent correct):

Race	FAMSUM 0	1	2	3	4
B	27.9	34.4	34.6	42.6	46.1
W	36.1	56.0	56.2	63.4	71.8

b. National mean score:

65.2

c. a - b:

B	-37.3	-30.8	-30.6	-22.6	-19.1
W	-29.1	- 9.2	- 9.0	- 1.8	6.6

Sample 2

Race	FAMSUM 0	1	2	3	4
B	35.8	37.1	42.0	43.9	50.4
W	40.7	52.3	58.0	65.5	71.9

66.3

B	-30.5	-29.2	-24.3	-22.4	-15.9
W	-25.6	-14.0	- 8.3	- 0.8	5.6

d. Weighted average of Samples 1 and 2:

Race	FAMSUM 0	1	2	3	4
B	-34.6	-30.1	-27.7	-22.5	-17.4
W	-27.3	-11.6	- 8.7	- 1.3	6.1

e. a - b - r (where r for blacks is -22 and for whites is 3):

B	-13	- 8	- 6	0	5
W	-30	-15	-12	-4	3

Exhibit 4-11. Effects of community type, age 17, Samples 1 and 2.

a. Mean mathematics score (percent correct):

Sample 1

Race	Community type ER	LM	Rest	HM
B	38.1	40.2	41.9	54.2
W	67.0	61.9	68.1	73.7

Sample 2

Race	Community type ER	LM	Rest	HM
B	39.0	45.5	45.0	67.8
W	68.0	65.2	68.5	75.2

b. National mean score:

Sample 1	Sample 2
65.2	66.3

c. a - b:

	Sample 1				Sample 2			
B	-26.9	-25.0	-23.3	-11.0	-27.3	-20.8	-21.3	1.5
W	- 1.8	- 3.3	2.9	8.5	1.7	- 1.1	2.2	5.9

d. Weighted average of Samples 1 and 2:

Race	Community type ER	LM	Rest	HM
B	-27.0	-22.9	-22.3	-2.4
W	- 0.1	2.1	2.6	7.2

e. a - b - r (where r for blacks is -22 and for whites is 3):

B	- 5	- 2	0	20
W	- 3	- 5	0	4

Exhibit 4-12. Effects of OCC, age 17, Samples 1 and 2.

a. Mean mathematics score (percent correct):

Sample 1

Race	OCC 1	2	3	4
B	38.3	42.0	41.8	46.7
W	59.4	61.5	67.1	71.6

Sample 2

Race	OCC 1	2	3	4
B	43.0	49.3	43.5	51.1
W	59.4	65.8	68.2	70.9

b. National mean score:

65.2 (Sample 1)

66.3 (Sample 2)

c. a - b:

Sample 1

B	-26.9	-23.2	-23.4	-18.5
W	- 5.8	- 3.7	1.9	6.4

Sample 2

B	-23.3	-17.0	-22.8	-15.2
W	- 6.9	- 0.5	1.9	4.6

d. Weighted average of Samples 1 and 2:

Race	OCC 1	2	3	4
B	-25.0	-20.6	-23.1	-16.6
W	-6.3	-2.0	1.9	5.5

e. a - b - r (where r for blacks is -22 and for whites is 3):

B	-3	1	-1	5
W	-9	-5	-1	3

Exhibit 4-13. Effects of region, age 17, Samples 1 and 2.

	Sample 1		Sample 2		
a. Mean mathmetics score (percent correct):					
	Region			Region	
Race	S	NCW	Race	S	NCW
B	40.1	42.1	B	43.8	47.3
W	64.1	69.4	W	64.6	70.0
b. National mean score:	65.2			66.3	
c. a - b:					
B	-25.1	-23.1	B	-22.5	-19.0
W	- 1.1	4.2	W	- 1.7	3.7

d. Weighted average of Samples 1 and 2:

	Region	
Race	S	NCW
B	-23.8	-21.0
W	-1.4	4.0

e. a - b - r (where r for blacks is -22 and for whites is 3):

B	-2	1
W	-4	1

f. Effect of region, combined over race:

S	NCW
-3	1

Effects of OCC are presented in Exhibit 4-12. For blacks at age 17, effects of OCC are essentially the same as for blacks and whites at age 13, ranging from -3 percent to 5 percent. For 17-year-old whites, effects of low OCC levels are more pronounced than at age 13, with values of -9 percent when OCC is 1 and -5 percent when OCC is 2.

Region. Region is defined at age 17 as it was at age 13. We estimate that 42 percent of the black 17-year-olds and 18 percent of the whites are in the Southeast. The data for race by region appear in Exhibit 4-13. Effects are quite similar to those found at age 13; the Southeast effect is -3 percent, contrasted with an effect of 1 percent for Northeast-Central-West.

Summary for Age 17. Exhibit 4-14 provides a schematic summary of effects at age 17. An index of the influence of effects (the difference between the largest and the smallest effect associated with a level of the variable) prescribes the following ordering of variables:

Variable	Influence
FAMSUM (for whites)	33 percent
Grade (for whites)	33 percent
Grade (for blacks)	31 percent
Community type (for blacks)	25 percent
FAMSUM (for blacks)	18 percent
Parental education	14 percent
OCC (for whites)	12 percent
OCC (for blacks)	8 percent
Community type (for whites)	7 percent
Region	4 percent

Compared with the findings for age 13, Grade has substantially greater influence at age 17, due perhaps to the two new levels made possible by the large number of dropouts and those above modal grade (including early graduates). The influences of FAMSUM and OCC for whites are greater at age 17 than at age 13, the influence of community type at age 17 appears greater for blacks and lesser for whites than at age 13, while the influences of parental education and of region are relativly unchanged from age 13.

Additional Variables at Age 17

For 17-year-olds, information was collected on two variables not available for 13-year-olds, mathematics courses taken in high school (MATHEXP) and grade point average over all high school courses (GPA). We turn briefly to an assessment of the effects of these two additional variables.

Mathematics Experience. Students at age 17 were asked whether they had taken courses in first-year Algebra/second-year Algebra, and Geometry. The variable MATHEXP is simply the number of "yes" answers to these three questions. MATHEXP takes on the possible values 0, 1, 2, or 3. We estimate

Exhibit 4.14. Schematic summary of effects within race, age 17.

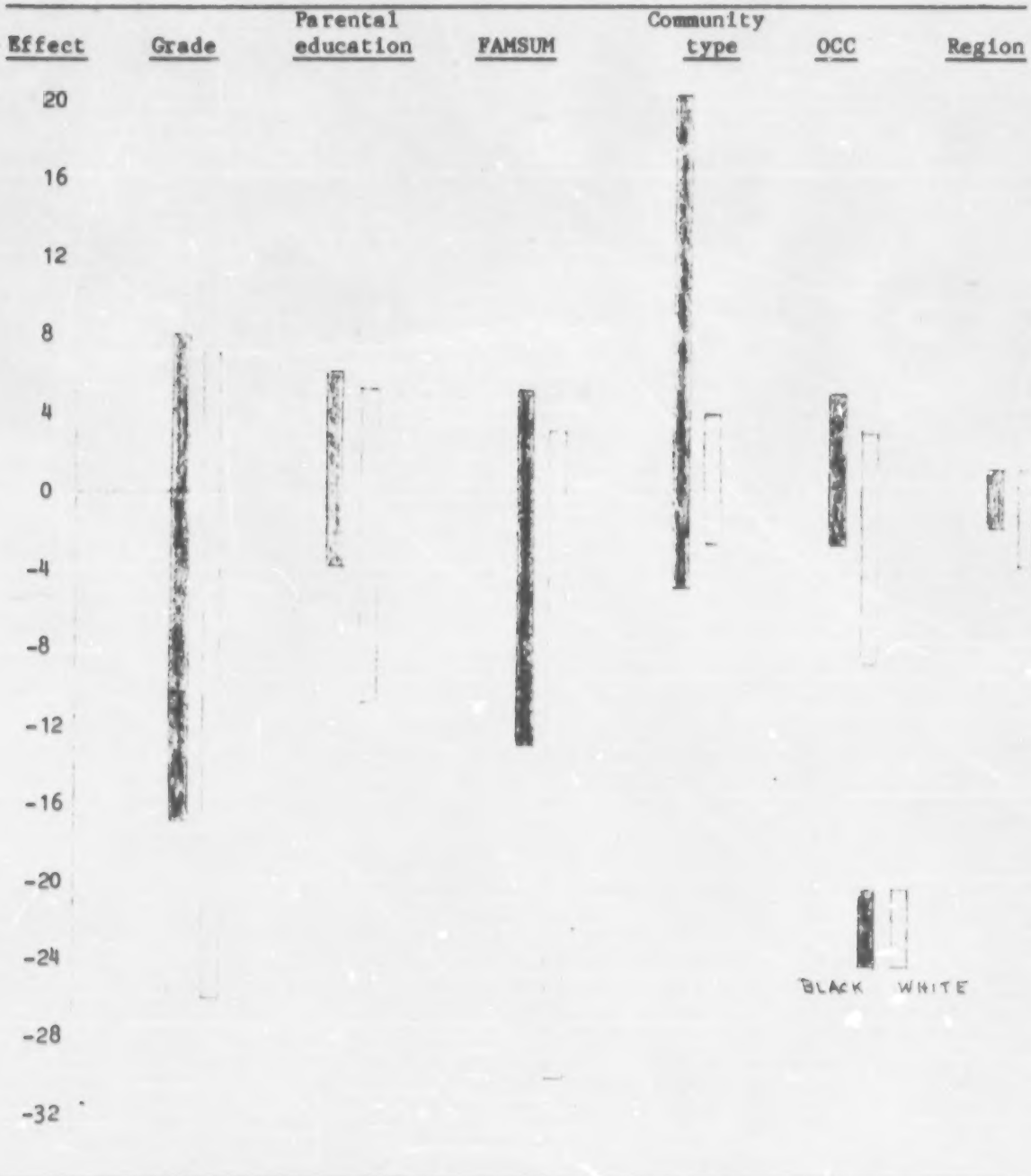


Exhibit 4-15. Effects of MATHEXP, age 17, Samples 1 and 2.

I. For females

a. Mean mathematics score (percent correct):

Sample 1

Race	MATHEXP 0	1	2	3
B	30.8	36.6	43.2	63.3
W	44.5	58.4	70.3	82.6

Sample 2

Race	MATHEXP 0	1	2	3
B	34.7	43.9	50.7	64.1
W	51.1	61.9	70.5	79.3

b. National mean score:

Sample 1	Sample 2
65.2	66.3

c. a - b:

	Sample 1				Sample 2			
B	-34.4	-28.6	-22.0	-1.9	-31.6	-22.4	-15.6	-2.2
W	-20.7	- 6.8	5.1	17.4	-15.2	- 4.4	4.2	13.0

d. Weighted average of Samples 1 and 2:

Race	MATHEXP 0	1	2	3
B	-32.9	-25.9	-18.7	-2.1
W	-17.9	-5.6	4.7	15.3

e. a - b - r - s (where s is -2, r for blacks is -22 and for whites is 3):

B	- 9	- 2	5	22
W	-19	- 7	4	14

Exhibit 4-15. (cont.)

II. For males

a. Mean mathematics score (percent correct):

	Sample 1				Sample 2				
	MATHEXP					MATHEXP			
Race	0	1	2	3	Race	0	1	2	3
B	34.6	43.6	51.5	64.2	B	37.5	43.0	52.3	72.2
W	50.2	64.0	74.9	87.1	W	54.4	63.8	74.0	84.0

b. National mean score:

	65.2					66.3			

c. a - b:

B	-30.6	-21.6	-13.7	-1.0	B	-28.8	-23.3	-14.0	5.9
W	-15.0	- 1.2	9.7	21.9	W	-11.9	- 2.5	7.7	17.9

d. Weighted average of Samples 1 and 2:

	MATHEXP			
Race	0	1	2	3
B	-29.6	-22.4	-13.8	3.0
W	-13.5	-1.9	8.8	19.8

e. a - b - r - s (where s is -2, r for blacks is -22 and for whites is 3):

B	-10	- 2	6	23
W	-19	- 7	4	16

III. Combined estimates for both sexes:

B	- 9	- 2	6	23
W	-19	- 7	4	15

Exhibit 4-16. Effects of GPA, age 17, Samples 1 and 2.

a. Mean mathematics score (percent correct).

Sample 1

Race	GPA							
	D-	D	C-	C	B-	B	A-	A
B	25.2	29.7	35.3	33.6	42.0	47.9	47.1	52.9
W	40.4	44.6	51.1	58.0	63.1	72.0	77.0	86.3

Sample 2

B	32.8	33.5	40.7	41.1	45.0	47.9	54.3	55.1
W	42.8	49.5	54.7	60.7	65.3	72.3	75.5	83.1

b. National mean score: Sample 1: 65.2

Sample 2: 66/3

c. a - b:

Sample 1

B	-40.0	-35.5	-29.9	-31.6	-23.2	-17.3	-18.1	-12.3
W	-24.8	-20.6	-14.1	- 7.2	- 2.1	6.8	12.7	21.1

Sample 2

B	-33.5	-32.8	-25.6	-25.2	-21.3	-18.4	-12.0	-11.2
W	-23.5	-16.8	-11.6	- 5.6	- 1.0	6.0	9.2	16.8

d. Weighted average of Samples 1 and 2:

B	-37.1	-34.0	-27.8	-28.1	-22.3	-17.8	-14.5	-11.7
W	-24.0	-18.6	-12.9	- 6.4	- 1.6	- 6.4	10.8	18.9

e. a - b - r (where r for blacks is -22 and for whites is 3):

B	-15	-12	- 6	-6	0	4	8	10
W	-27	-22	-16	-9	-5	3	8	16

that 17-year-old black females and males and white females and males are distributed as follows over levels of MATHEXP:

Female	MATHEXP				
Race	0	1	2	3	
B	29.3	38.6	20.5	11.6	(100.0)
W	17.3	26.0	26.4	30.8	(100.0)
Male					
B	27.4	35.5	22.0	15.1	(100.0)
W	18.0	23.0	25.6	33.4	(100.0)

Exhibit 4-15 shows the estimation of effects of levels of MATHEXP, separately by race and sex. Effects for females and males, within race, are found to be essentially the same, and are combined in panel III of Exhibit 4-15. For blacks, effects range from -9 percent when MATHEXP is 0 to 22 percent when MATHEXP is 3. Corresponding effects for whites are -19 percent and 14 percent.

Grade Point Average. The variable GPA is defined to take on values from 1 to 8, with higher numbers representing higher self-reported high school grade point averages. We estimate that black and white 17-year-olds are distributed as follows over levels of GPA:

	GPA								
Race	D-	D	C-	C	B-	B	A-	A	
B	1.4	3.0	11.4	17.4	32.4	16.8	13.4	3.2	(100.0)
W	0.8	2.0	7.6	13.3	23.9	19.5	20.8	12.1	(100.0)

Exhibit 4-16 shows the effects of levels of GPA for black and white 17-year-olds. For blacks, the effects range from -15 percent when GPA is D- to 10 percent when GPA is A. For whites, the range of effects is greater, from -27 percent to 17 percent.

The influences of these additional, individual achievement variables are dramatically large. For MATHEXP, the range of effects is 31 percent for blacks and 33 percent for whites. For GPA, the range is 25 percent for blacks and 43 percent for whites. No other variables are associated with larger effects.

Chapter 5

Predicting Achievement from Background Characteristics

In Chapter 4, we found that the level of performance on mathematics exercises was systematically related to each of a number of background variables. We looked at the influence of each variable separately, and the influence of each was assessed separately for black and white students at age 13 and at age 17.

Here we shall take a different approach, to find the correlation between performance on the mathematics exercises and background variables as a set. That correlation will be determined first for a sample as a whole--including blacks and whites, females and males--and we shall find that linear combination of background variables that correlates best with the percentage of correct answers on the mathematics exercises. We then shall determine the extent to which that linear combination of the background variables accounts for race and sex differences in mathematics achievement. Subsequently, we shall find the correlations separately for blacks and whites to determine whether there are differences associated with race. The methods employed are those of linear multiple regression (e.g., Mosteller and Tukey, 1977).

An ambitious effort to employ multiple regression to allocate effects of school and individual variables on achievement was that of Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld and York (1966), Equality of Educational Opportunity. This study will not be reviewed here. The interested reader is referred, for criticisms of that effort, to Armor (1972), Mosteller and Moynihan (1972), and Spady (1976).

A study more directly relevant to the present work is that of Mullis (1978), based on analysis of the same raw data from the National Assessment of Educational Progress as that analyzed here. It is pertinent to comment on Mullis's findings and conclusions.

The Mullis Study

For her analysis, Mullis (1978) used Coleman's (1975) method of reanalysis of data from the International Educational Assessment (IEA). The purpose of both these studies was to determine the relative importance of school variables as causes of learning.

> The basic proposition underlying the model is that earlier events influence later events. The home influences the type of school and community; home and the type of school influences the methods of instruction; and all three influence achievement. (Mullis, 1978, p. 42).

The "home" block of variables included not only such variables as mother's and father's education and items in the home, but also race and sex. The type of school and community block included region of the country, size of community, rural/urban and inner-city/suburban indices, as well as the percent of white students in the school and the percent of students who qualified for ESEA Title I assistance. The type of academic program for the student (academic or vocational) also was included in this block. (In many countries separate schools are dedicated to separate academic tracks.)

In contrast, the grade level of the student--which, like the academic track, is partly the result of past achievement--was included in the third, "school instruction," block. The third block of variables also included indices of the basic and advanced mathematics courses taken and some measures of teaching practices.

These three blocks were entered sequentially into a linear least-squares multiple regression equation and indices of the relative contribution of each block of variables were computed. These indices contrasted various ways of apportioning the variance in achievement that is uniquely explained by each block and the variance in achievement that is explained commonly by two or more of the blocks. Exhibit 5-1 summarizes the variance accounted for uniquely and jointly by the three blocks of variables (Mullis, 1978, p. 84). Note that more of the variance in achievement can be explained uniquely by variables in Block 3 than by variables in Blocks 1 and 2.

Some of the results for individual variables within blocks for mathematics deserve comment. By far the most influential variables in the individual block are race and sex. Including these variables in the individual block begs the question of the present study, that is, what variables are associated with race and sex differences. In the second block, nearly all of the explained variance is accounted for by the academic program variable.

The most serious defect of the Mullis study for our present purposes is the assumption of a known causal sequence. This is a common assumption in the literature, and plays some role in the original Coleman et al. study, Equality of Educational Opportunity (EEO), the reanalyses of EEO by Armor (1972), Mayeske et al. (1972); the analyses of the International Educational Assessment (Comber and Keeves, 1973; Purves, 1973; Thorndike, 1973); and Coleman's (1975) reanalysis of the IEA.

Briefly, we hold that causal direction cannot be determined in this type of study. For example, race or sex may well be school or community variables in their causal relationship to achievement. That is, races may differ in mathematics achievement not because of native ability or parental contribution, but because of what society expects of minorities or because of the course sequences to which black students have been assigned. As another example, the number of books in the home may be a reaction of the parents to the child's performance in school rather than the opposite.

Exhibit 5-1. Variance in mathematics achievement at age 17 accounted for by (1) home background, (2) community type, and (3) school instruction.

Source of variance	Percent of variance accounted for
Uniquely by:	
Block (1)	7.1%
Block (2)	2.5%
Block (3)	19.8%
Jointly by:	
(1), (2) and (3)	22.9%
Total:	52.5%

If one sets aside causal assumptions, it is still instructive to apportion variables to blocks. One way that seemed important to us was to separate differences that can be observed at the school level--including regional and community variables as well as school means for individual variables--from the residual differences among individuals within schools. By separating school variables from individual variables, we can ask not only how the overall variance in mathematics scores is divided between schools and individuals, but the entirely separable question of where race and sex differences can be accounted for. Do the variables that are associated with race and sex differences appear mainly at the institutional level, mainly among individuals within institutions, or equally at both levels? This analysis does not assume that variables included at the school level are caused by schools. Good schools may draw professional families; professional families may influence schools to improve; professional families may encourage their children to achieve; teachers may favor middle-class children; all of these factors and others may be (and probably are) simultaneously at work.

Lindquist (1930) called attention to the fact that there is considerable variance in average achievement among schools in an early discussion of methods of selecting norms samples for tests. Lord (1959) estimated that the standard deviation of school means is about 40% as large as the standard deviation of individual scores. Lindquist (1966) asserted that the proportion of variance accounted for by schools is greater with subjects (perhaps like mathematics) that are learned primarily in school.

A recent meta-analysis of 620 studies by White (1982) shows that "SES" variables (defined rather broadly to include parents' income, occupation, education, reading materials, stability, and a number of others--even, in four studies, ethnicity) account for much more variance in school mean achievement scores (an average of 50%) than variance among individuals (an average of 5%). To the extent we believe race to be functioning like these SES variables, we would expect race differences to be accounted for better at the school than at the individual level.

The Present Study

Regression for Both Races

Our first regression analyses are performed for the pooled respondents--black and white, female and male--separately for age 13, Sample 1, age 13, Sample 2, age 17, Sample 1, and age 17, Sample 2. In a later section we will report results of separate analyses by race.

Among our background variables are a number that are associated with schools, and additional variables that differ among individuals within school. The school variables available both at ages 13 and 17 are:

region
community type
parental occupation levels
mean grade of sampled students
mean parental education for sampled students
mean FAMSUM of sampled students

Three variables with within-school variation among individuals are available at both ages: grade, parental education, and FAMSUM. For our analyses, each of these individual variables has been entered as a set of deviations from the sample mean, for that variable, in the school from which an individual has been sampled. (At age 17, dropouts and early graduates were sampled from lists from sampled schools, and are assigned to the school of last attendance.)

Regression Solutions

We ask first the extent to which achievement scores are linearly related to the set of six school variables available at both ages. Results appear in Exhibit 5-2, where R^2_s is the squared multiple correlation coefficient found from the regression of achievement scores on the six school variables, R^2_s is the squared multiple correlation coefficient found from the regression of achievement on all nine variables, and the remaining entries are standardized regression coefficients[1] associated with the background variables.

Each value of R^2 may be interpreted as the percentage of the variance of achievement scores that is predicted from a linear combination of the background variables. From Exhibit 5-2 it is seen that R^2_s ranges between .15 (for age 17, Sample 1) to .19 (for age 13, Sample 2), from which we may conclude that about one-sixth of the variance in achievement scores is predictable from the six school variables. R^2_t ranges between .29 and .34; about one-third of the variance in achievement scores is predictable from all nine background variables. Further, about half of the predictable variance is associated with school-to-school differences, and about half is associated with individual differences within schools.

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[1]The multiple regressions were executed by PROC SYSREG of the Statistical Analysis System (SAS). To obtain standardized regression coefficients, each raw coefficient in the computer output was first multiplied by the standard deviation of the corresponding background variable and then divided by the standard deviation of the achievement score. The resulting coefficients are those that would be employed were all variables to be in standard-score form.

Several conclusions may be drawn from the regression coefficients given in Exhibit 5-2. For each age and sample, the most influential predictor of achievement in this set of predictors is grade. Among the school variables, mean FAMSUM, mean grade, and OCC are consistently good predictors. Among the individual variables, in addition to grade, both parental education and FAMSUM consistently contribute to the prediction.

At age 17, two additional background variables are available, mathematics experience (MATHEXP) and GPA, both as reported by the students. In Chapter 4, each of these was seen to be associated with achievement. It is of interest now to consider their predictive value when they are added to the set of nine variables that were available at both ages. In the spirit of the analysis presented here, we shall add mean MATHEXP and mean GPA as school variables (entering the school means in each case), and add as individual variables the deviations from the school mean for MATHEXP and GPA. Results appear in Exhibit 5-3.

A comparison of values of R_s^2 in Exhibit 5-3 with those for age 17 in Exhibit 5-2 shows only an increase of about .02 due to the addition of the two school variables, mean MATHEXP and mean GPA. A similar comparison of values of R_t^2 shows a much larger increase of .20 due to the addition not only of mean MATHEXP and mean GPA, but also of the individual deviations in MATHEXP and GPA from the school means, resulting in values of R_t^2 of about .52. Slightly over half of the variance in achievement scores now is accounted for by the full set of background variables.

Note, from Exhibit 5-3, the prominence of the regression coefficients for MATHEXP. It is reassuring to find that the mathematics achievement scores are to some extent related to the number and variety of mathematics courses reported to have been taken in high school.

Effects of Regression Adjustment on Group Differences in Achievement. In Chapter 3, we reviewed evidence of differences in mean achievement scores by race and sex at ages 13 and 17. It is of interest to see the extent to which those differences remain if, for every individual, we use as an adjusted achievement score the residual from a linear multiple regression line. Results of this inquiry are given in Exhibit 5-4, in units of mean percent correct, and in Exhibit 5-5, in units of within-group standard deviations. Because within-group standard deviations differ by age and sample, the results in the form of Exhibit 5-5 are comparable over ages and samples, and better serve as the focus of discussion.

At age 13, the unadjusted data show the mean score for black females to be about .9 σ_w below the national mean and that for black males to be about 1.0 σ_w below the national mean. After regression on school variables, the difference from the nation for both females and males is reduced to about two-thirds of its unadjusted value. After further regression on the individual variables, the difference is further reduced, modestly for black males and only slightly for black females. The regression adjustment appears

Exhibit 5-2. Results from regression of achievement scores on the variables common to ages 13 and 17.

Age and Sample	R^2_s	R^2_t	School variables						Individual variables		
			Reg.	Comm. type.	OCC	Mean grade	Mean par.ed.	Mean FAMSUM	Par. Grade	Par. Ed.	Par. FAMSUM
13-1	.169	.336	.11	-.03*	.14	.16	.07	.17	.27	.13	.19
13-2	.193	.339	.07	.01	.13	.17	.08	.16	.26	.16	.15
17-1	.150	.294	.04*	-.04*	.18	.10	.10	.15	.26	.16	.12
17-2	.162	.313	.04*	.00*	.12	.13	.14	.17	.27	.16	.11

*Coefficient fails to differ significantly from 0 at the .001 level of significance.

Exhibit 5-3. Results from regression of achievement scores on all background variables, age 17.

Sample	R_s^2	R_t^2	School variables								Individual variables				
			Reg.	Comm. type	OCC	Mean grade	Mean par.ed.	Mean FAMSUM	Mean MATHEXP	Mean GPA	Grade	Par. ed.	FAMSUM	MATHEXP	GPA
1	.165	.533	.03*	-.05	.13	.05	.06	.13	.11	.08	.13	.08	.05	.39	.21
2	.182	.515	.03*	.00*	.09	.05	.10	.15	.12	.10	.14	.08	.06	.35	.20

*Coefficient fails to differ significantly from 0 at the .001 level of significance.

to be moderately stronger for black males than for black females. For 13-year-olds, the mean white-black differences in residuals from the regression line is 58 percent of the mean difference in unadjusted scores.

At age 17, for unadjusted data, the mean for black females is about 1.3 σ_w below and that for black males is about 1.0 σ_w below the national average. As was the case at age 17, regression on school variables reduces the difference to about two-thirds of the unadjusted difference (and the result is the same whether or not mean MATHEXP and mean GPA are included among the school variables). Again, as at age 13, further regression on the individual variables effects a further modest reduction in the mean difference from the national average for black males and a smaller reduction for black females. The regression adjustments leave the mean for black females about .7 σ_w below the national mean and that for black males about .5 σ_w below. For both black females and males, regression has accounted for close to half of the unadjusted mean difference from the national average.

We have seen that the difference between mean levels of performance on the mathematics exercises for blacks and whites is reduced substantially by regression adjustment. At age 13, the mean difference in residuals from the regresson line is less than 60 percent of the mean difference in unadjusted scores; at age 17, it is 50 percent of the unadjusted difference. Put another way, at age 13, the white-black difference has been reduced from 1.1 σ_w to .6 σ_w, and at age 17, it has been reduced from 1.4 σ_w to about .7 σ_w.

How should we interpret the effects of regression in reducing the white-black mean difference? The observed reduction should be viewed as a lower limit on the reduction that would be achieved were we to have available more satisfactory measures of the home and school variables that are relevant to levels of achievement in mathematics. The background variables here are only gross indices of the variables we would wish for, and consequently the multiple correlations are lower than they would be if we had better variables. Given that the variables available to us are so imperfect as indices of relevant background characteristics, it is somewhat surprising (a) that the R^2 values are as large as they are, and (b) that the regression accounts for as much of the group difference as it does.

A remarkable result of our analysis is that white-black mean differences are reduced more by regression on the school variables than on the individual-within-school variables. While these two sets of variables contribute roughly equally to the R^2 values, the school-to-school differences in background variables account for substantially more of the white-black mean differences then do the within-school differences in background variables.

Regressions Separate by Race

The regression analyses performed thus far have been based upon pooled samples of black and white students. To determine whether the regression structure is similar for blacks and for whites, we now provide separate analyses for the two racial groups. Results comparable to those of Exhibit 5-2 appear in Exhibit 5-6. Note the addition, here, of one school variable, percent white children in the school (as estimated by the school principal). Since this variable is confounded with race of the respondents, it was not included in the regression analyses of combined racial groups, but may prove of interest in within-race regression analyses.

Exhibit 5-4. Group differences as means of residuals from regression lines, ages 13 and 17. All values are deviations from the national mean percentage correct.

	Sample 1			Sample 2		
		Sex			Sex	
Age 13	Race	F	M	Race	F	M
Raw data:	B	-14.6	-17.2	B	-13.6	-14.5
	W	2.5	2.5	W	1.8	2.6
Residual from regression on school variables:	B	-9.3	-11.0	B	-9.6	-9.4
	W	1.3	1.9	W	0.8	2.2
Residual from regression on all variables:	B	-8.6	-8.6	B	-9.1	-8.1
	W	0.7	2.0	W	0.4	2.4
Age 17						
Raw data:	B	-26.6	-20.6	B	-21.7	-18.9
	W	1.0	5.5	W	0.6	4.8
Residual from regression on school variables of Exhibit 5-2:	B	-16.6	-12.8	B	-13.8	-11.9
	W	-0.4	4.5	W	-0.2	3.7
Residual from regression on all variables of Exhibit 5-2:	B	-15.7	-10.8	B	-13.3	-10.0
	W	-1.0	4.8	W	-0.6	3.9
Residual from regression of school variables of Exhibit 5-3:	B	-16.5	-13.2	B	-13.7	-11.8
	W	-0.4	4.5	W	-0.2	3.7
Residual from regression on all variables of Exhibit 5-3:	B	-13.9	-9.6	B	-12.0	-8.8
	W	-1.8	5.2	W	-1.1	4.0

Exhibit 5-5. Standardized results from Exhibit 5-4, in units of the within-group standard deviation.

Age 13	Sample 1			Sample 2		
		Sex			Sex	
	Race	F	M	Race	F	M
Raw data:	B	-.89	-1.05	B	-.90	-.96
	W	.15	.15	W	.12	.17
Residual from regression on school variables:	B	-.57	-.67	B	-.64	-.62
	W	.08	.12	W	.05	.15
Residual from regression on all variables:	B	-.52	-.52	B	-.60	-.54
	W	.04	.12	W	.03	.16
Age 17						
Raw data:	B	-1.32	-1.02	B	-1.28	-1.11
	W	.05	.27	W	.04	.28
Residual from regression on school variables of Exhibit 5-2:	B	-.83	-.64	B	-.81	-.70
	W	-.02	.22	W	-.01	.22
Residual from regression on all variables of Exhibit 5-2:	B	-.78	-.54	B	-.78	-.59
	W	-.05	.24	W	-.04	.23
Residual from regression of school variables of Exhibit 5-3:	B	-.82	-.66	B	-.81	-.69
	W	-.02	.22	W	-.01	.22
Residual from regression on all variables of Exhibit 5-3:	B	-.69	-.48	B	-.71	-.52
	W	-.09	.26	W	-.06	.24

The values of R^2 within race, Exhibit 5-6, tend to be smaller than those for both races combined, Exhibit 5-2 (except for 13-year-old blacks, where they are comparable in size). This was expected, to the extent that differences between blacks and whites in levels both of predictor variables and achievement scores were contributing to the relationship. Of greater interest is the finding that the values of R^2 here are not much smaller, suggesting that the structural relations found in the combined samples also are found when the samples are separated by race.

The values of R^2_s within race are higher at age 13 than at age 17; i.e., school-to-school differences are associated with achievement score differences to a greater extent at the younger age.

Both at age 13 and at age 17, the values of R^2_s are larger for black students than for whites; i.e., school-to-school differences are associated with achievement score differences to a greater extent for black students than for white students. Also, for black students R^2_s is a larger fraction of R^2_t than for whites, 50 percent as large or larger for blacks, and uniformly less for whites. Thus, for black students, school-to-school differences make up the larger proportion of the variance related to achievement, while for white students, individual differences within schools make up the larger portion.

The values of R^2_t within race tend to be slightly smaller than those for blacks and whites combined (Exhibit 5-2). The difference between R^2_t and R^2_s, i.e., the R^2 attributable to individual differences within race and within schools, is uniformly greater for whites than for blacks. The difference is about .17 for whites at each age for each Sample, and is about .11 for blacks (but rising to .15 at age 13, Sample 1).

Directing attention to the standardized regression coefficients[2] for the school variables in the body of Exhibit 5-6, mean grade in school is seen to be the most consistently related to achievement. For whites, but not for blacks, mean FAMSUM, OCC, and mean parental education are consistently associated with significant positive regression coefficients. For mean FAMSUM, the regression coefficients are of comparable size for blacks and whites; the smaller sample size for blacks prevents them from attaining statistical significance.

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[2] As before, these are found by multiplying each corresponding raw coefficient by the standard deviation for that predictor, and dividing by the standard deviation of achievement scores. Here, the standard deviations are those for the separate groups of black and white students at each age and Sample.

Exhibit 5-6. Results of regression, separately by race, of achievement scores on the variables common to ages 13 and 17.

Race	Age and Sample	R_s^2	R_t^2	School variables							Individual variables		
				Reg.	Comm. Type	OCC	Mean grade	Mean par.ed.	Mean FAMSUM	Percent white	Grade	Par. ed.	FAMSUM
B	13-1	.188	.340	.18	-.06*	.22	.21	.06*	.11*	.01*	.27	.11	.15
B	13-2	.196	.310	.07*	.04*	-.03*	.27	-.06*	.21	.27	.27	.11*	.10
W	13-1	.110	.286	.08	-.02*	.12	.15	.05	.14	.01*	.29	.13	.18
W	13-2	.148	.312	.05	.01*	.12	.16	.08	.14	.00*	.28	.17	.16
B	17-1	.097	.194	.00*	.02*	-.02*	.11*	.02*	.17*	.13*	.27	.03*	.10*
B	17-2	.132	.251	.00*	-.13*	.25	.19	.07*	.09*	-.01*	.22	.13	.08*
W	17-1	.082	.253	.03*	-.04*	.11	.12	.09	.10	.06	.29	.15	.11
W	17-2	.092	.266	.02*	.01*	.07	.13	.10	.13	.03*	.31	.18	.11

*Coefficient fails to differ significantly from 0 at the .001 level of significance.

Among the individual variables, grade has uniformly high value for predicting achievement for blacks and whites at both ages. Parental education and FAMSUM also contribute to the prediction for whites, but not always significantly for blacks.

Exhibit 5-7 shows results of the regression for 17-year-olds by race, comparable to Exhibit 5-3 for combined groups (but with the addition of the variable, percent white among the students in a school).

The values of R^2_s within race (Exhibit 5-7) are smaller than those for combined races (Exhibit 5-3). For black 17-year-olds, the values of R^2_t also are smaller, while for whites they are of comparable size (.53 and .50).

Assessing standardized regression coefficients for school variables, we find that mean MATHEXP is consistently a good predictor of mathematics achievement, and its coefficients are higher within race than they were for the combined samples (Exhibit 5-3). Among the individual variables, MATHEXP, GPA, and grade are consistently good predictors of achievement for both races.

One somewhat surprising finding is the relatively low apparent predictive value of percent white, for 13-and 17-year-old black students and white students. Armor (1972, p. 223) reported that, in the Coleman data for 6th graders, the few whites in majority-black schools "show the lowest achievement of any group," with "scores over 3 standard deviations lower than whites in majority white schools," and also that "black achievement within majority white schools is higher than black achievement within majority black schools." At age 13, Exhibit 5-8 displays the distribution of black students and white students over levels of percent white in the school, and shows at each level the discrepancy of the mean percent correct from the overall mean for the appropriate race. It appears that neither for blacks nor whites is there a monotonic relation of mean achievement with percent white students in the school. Yet, some consistency is seen in the two Samples for each race, and also for blacks and for whites. In schools less than 70 percent white, mean mathematics achievement of black students is below the mean for all blacks, and mean achievement for whites is at or below the mean for all whites. Mean achievement for blacks is unusually high in schools that are 70-79 percent or 90-100 percent white, but not in schools that are 80-89 percent white. White students in schools 80-89 percent white show mean achievement about 3 percent below the national mean for whites.

Exhibit 5-9 shows comparable data to that in Exhibit 5-8, but at age 17. Results appear somewhat more variable, but not dissimilar from those at age 13. In schools less than 70 percent white, mean achievement tends to be below the overall mean for each race. As at age 13, mean achievement of whites in schools reported to be 100 percent white is consistently lower than mean achievement of whites in schools that are 90-99 percent white.

Exhibit 5-7. Results of regression, separately by race, of achievement scores on all background variables, age 17.

Race	Age and Sample	R_s^2	R_t^2	School variables								Individual variables				
				Reg.	Comm. Type	OCC	Mean grade	Mean par.ed.	Mean FAMSUM	Percent white	Mean MATHEXP	Mean GPA	Grade	Par. ed.	FAMSUM	MATHEXP	GPA
B	17-1	.118	.351	-.03*	.01*	-.03*	.08*	.03*	.11*	.17	.17	.08*	.19	.03*	.08*	.34	.14
B	17-2	.159	.434	.00*	-.06	.14	.12	.04*	.09*	.04*	.19	.02*	.14	.09	.02*	.34	.13
W	17-1	.103	.531	.02*	-.05	.04*	.06	.07	.08	.07	.16	.05	.14	.08	.04	.41	.23
W	17-2	.117	.498	.02*	.02*	.02*	.06	.06	.09	.05	.16	.07	.16	.07	.06	.36	.23

*Coefficient fails to differ significantly from 0 at the .001 level of significance.

Exhibit 5-8. Distributions over levels of percent white in school and deviations of mean achievement scores by level of percent white from overall mean by race, age 13.

Race	Percent white	Proportion of total Sample		Deviation from mean percent correct by race*	
		Sample 1	Sample 2	Sample 1	Sample 2
B	0-9	.21	.19	-1.7	-6.8
	10-49	.18	.20	-1.8	-0.7
	50-69	.16	.16	-6.0	-5.0
	70-79	.19	.17	5.3	9.3
	80-89	.20	.23	0.2	0.3
	90-100	.06	.06	8.3	9.1
W	0-59	.03	.04	-6.1	-5.6
	60-69	.05	.04	0.5	-1.0
	70-79	.11	.10	-0.8	-0.1
	80-89	.14	.16	-2.9	-2.9
	90-99	.49	.50	1.2	1.3
	100	.18	.17	0.6	0.6

*Mean percent correct for blacks at age 13 is 52.2 in Sample 1, 57.0 in Sample 2, and for whites is 70.5 in Sample 1 and 73.2 in Sample 2.

Exhibit 5-9. Distributions over levels of percent white in school and deviations of mean achievement scores by level of percent white from overall mean by race, age 17.

Race	Percent white	Proportion of total Sample		Deviation from mean percent correct by race*	
		Sample 1	Sample 2	Sample 1	Sample 2
B	0-9	.23	.27	-4.3	-3.1
	10-49	.28	.25	-1.0	-1.1
	50-69	.21	.23	0.1	-2.3
	70-79	.07	.08	-1.2	10.0
	80-89	.14	.10	4.6	3.1
	90-100	.07	.06	11.6	7.1
W	0-59	.05	.05	-10.2	-3.9
	60-69	.03	.04	-9.6	-4.7
	70-79	.06	.07	-3.8	-6.0
	80-89	.20	.19	1.5	1.0
	90-99	.54	.53	1.6	1.3
	100	.13	.12	-1.3	-1.4

*Mean percent correct for blacks at age 17 is 41.2 in Sample 1, 45.9 in Sample 2, and for whites is 68.4 in Sample 1 and 69.0 in Sample 2.

The picture is a complex one. Undoubtedly, percent white in the school is confounded with region and with type of community (and with OCC and with FAMSUM), which would prevent any straightforward interpretation of its relation to achievement. Moreover, the distribution of black students over schools was changing during the seventies, making even more difficult an interpretation of a snapshot in 1975-76.

One difference between the findings at age 13 and 17 does emerge, pertaining to the distribution of black students over "percent white." At 13, in 1975-76, about 55 percent of black students attended schools that are less than 70 percent white, while at 17, almost 75 percent of the black students attended such schools.

Armor (1972), in his re-analysis of Coleman's 1965 achievement data, focussed on mean achievement differences between black sixth-graders in "black schools" and white sixth-graders in "white schools." For Armor's analysis, a black school was defined to be one in which there were more than 50 percent black students; a white school was one in which 50 percent or more of the students were white. Analyzing scores on a verbal achievement test, Armor showed that the mean achievement score for black students in black schools was below the mean for white students in white schools by about 2 times the national standard deviation. The mean score difference was 12, the standard deviation was 6 (Armor, 1972, Table 7, p. 200). Given the high correlation between verbal achievement scores and mathematics achievement scores (r=.93), Armor argued that the finding also probably was valid for mathematics achievement.

We are able to analyze our 1975-76 data in precisely the same way as Armor did. The data were collected ten years later, they assess mathematics achievement rather than verbal achievement, and they pertain to 13-year-olds rather than to sixth-graders.

The mean levels of achievement in percent of exercises correct for blacks in predominantly black schools and for whites in predominantly white schools are found to be:

Blacks		Whites	
Sample 1	Sample 2	Sample 1	Sample 2
53.3	70.6	73.4	50.4

(Note that 39 percent of the nation's black 13-year-olds were enrolled in predominantly black schools, while 97 percent of the nation's white 13-year-olds were enrolled in predominantly white schools.)

The differences between means of whites in white schools and blacks in black schools are seen to be 20.2 percent for Sample 1, 20.1 percent for Sample 2. The corresponding national standard deviations are 17.5 and 16.6 (somewhat larger than the within-group standard deviations in Exhibits 3-1 and 3-2, as we would expect). Thus, the 1975 mean difference in mathematics achievement scores between white students in white schools and black students in black schools is about 1.2 standard deviations, not 2 standard deviations as reported by Armor for 1965 data. It is reasonable to conclude that the differences in mean achievement between the races and/or between the schools diminished markedly between 1965 and 1975.

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